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Hwang et al.

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(54) **VERTICAL TYPE SEMICONDUCTOR DEVICES**

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H01L 29/792 (2006.01)
H01L 27/115 (2006.01)

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CPC **H01L 29/66833** (2013.01); **H01L 27/11575** (2013.01); **H01L 27/11582** (2013.01); **H01L 29/7926** (2013.01)

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CPC H01L 27/11582; H01L 27/11578; H01L 27/11575; H01L 29/7926; H01L 29/66833; H01L 29/792

See application file for complete search history.

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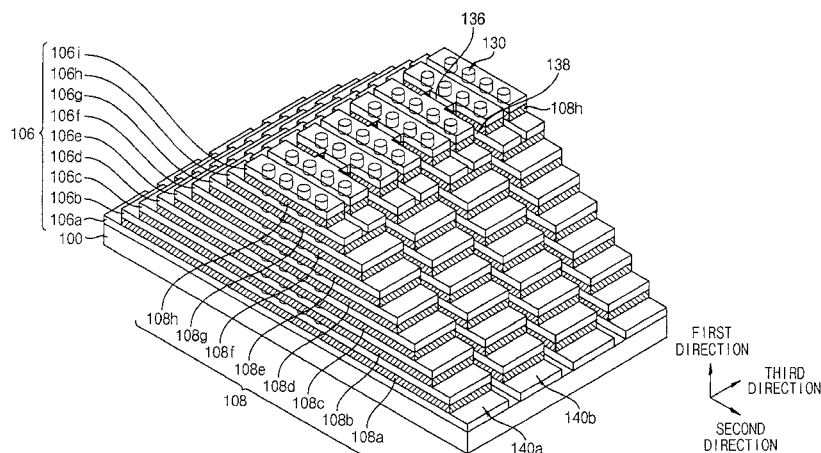
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(57) **ABSTRACT**

A vertical type semiconductor device includes first and second word line structures that include first and second word lines. The word lines surround a plurality of pillar structures, which are provided to connect the word lines to corresponding string select lines. Connecting patterns electrically connect pairs of adjacent first and second word lines in a same plane. The device may be a nonvolatile memory device or a different type of device.

20 Claims, 31 Drawing Sheets



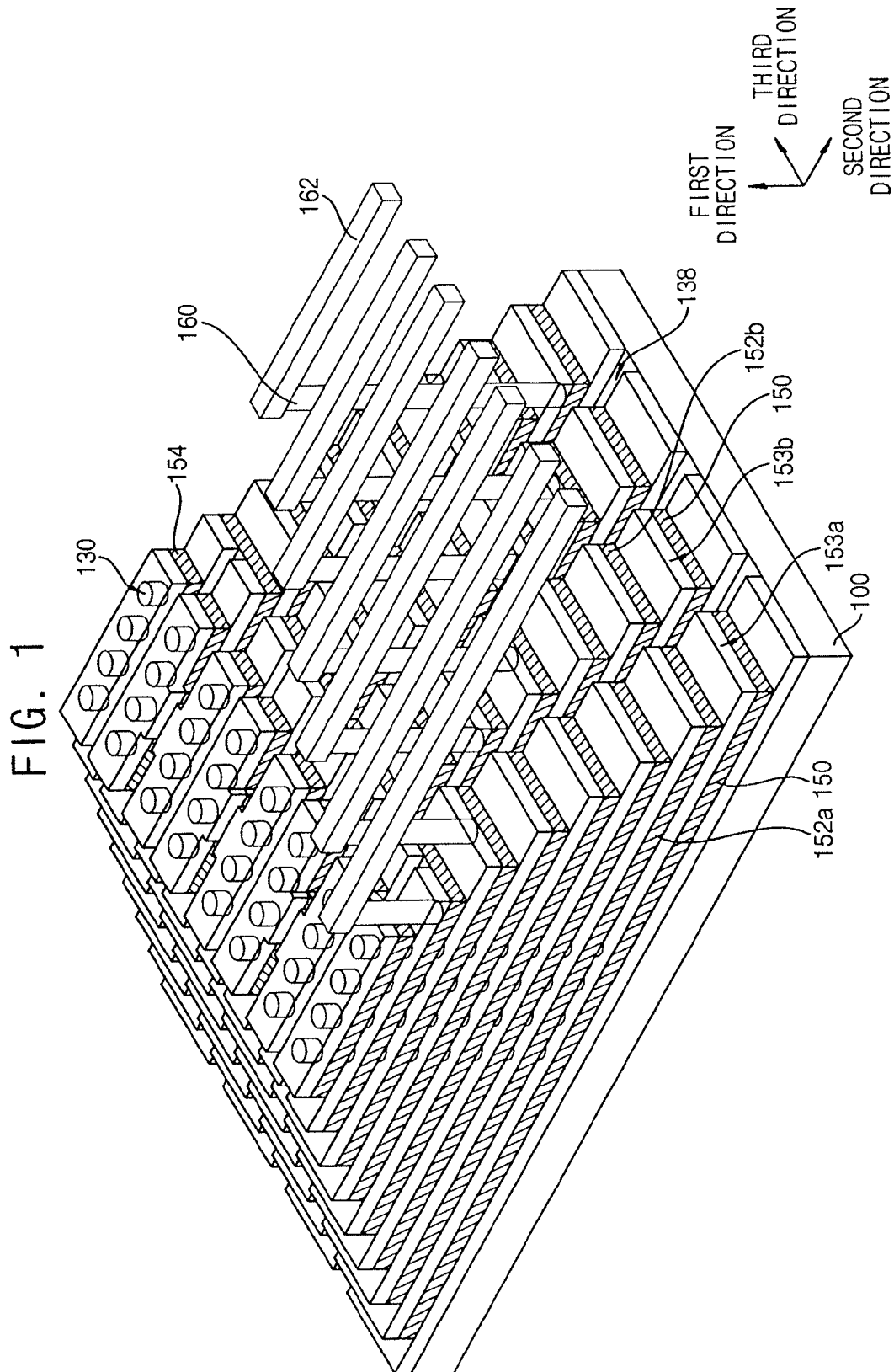


FIG. 2A

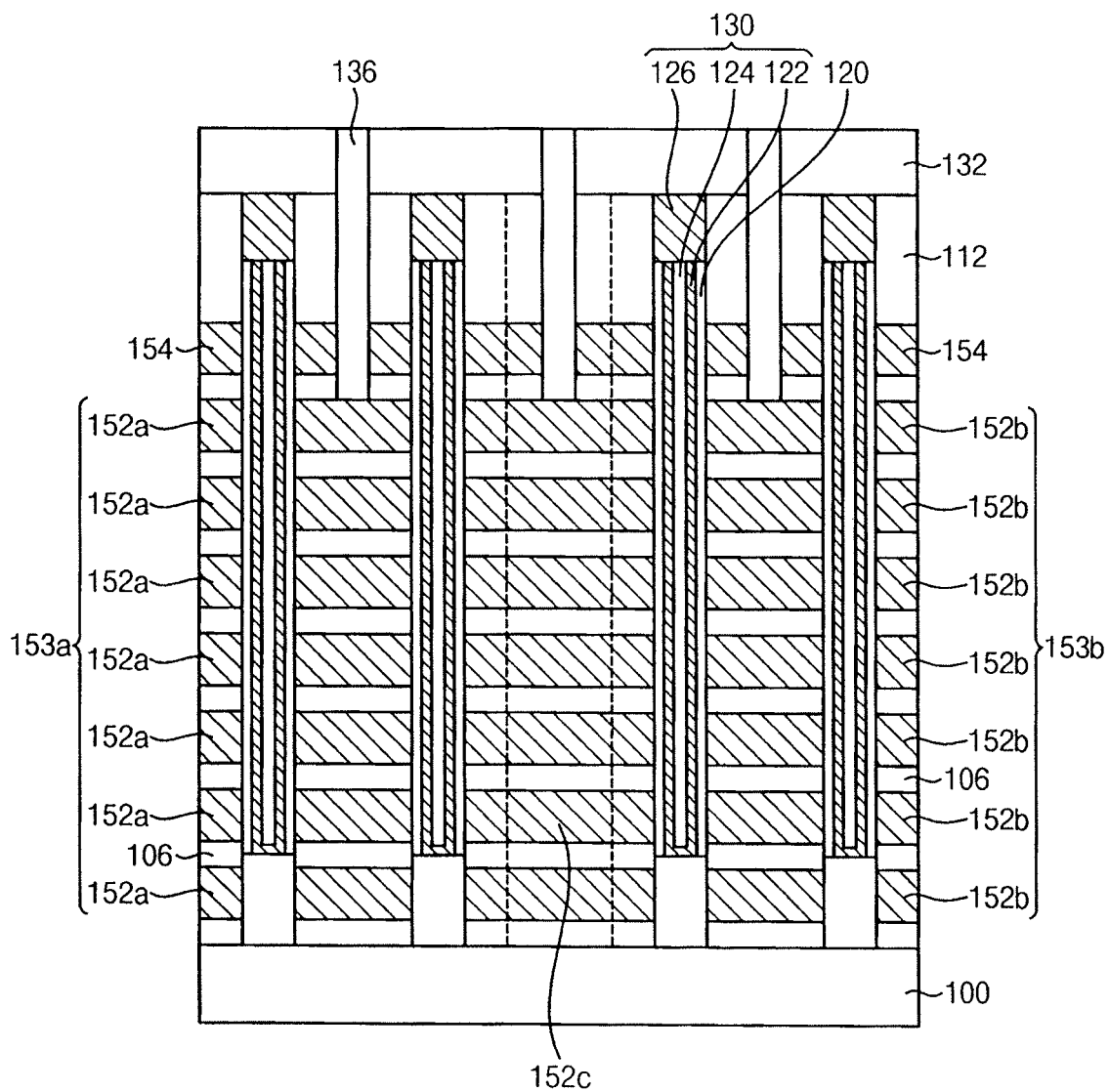


FIG. 2B

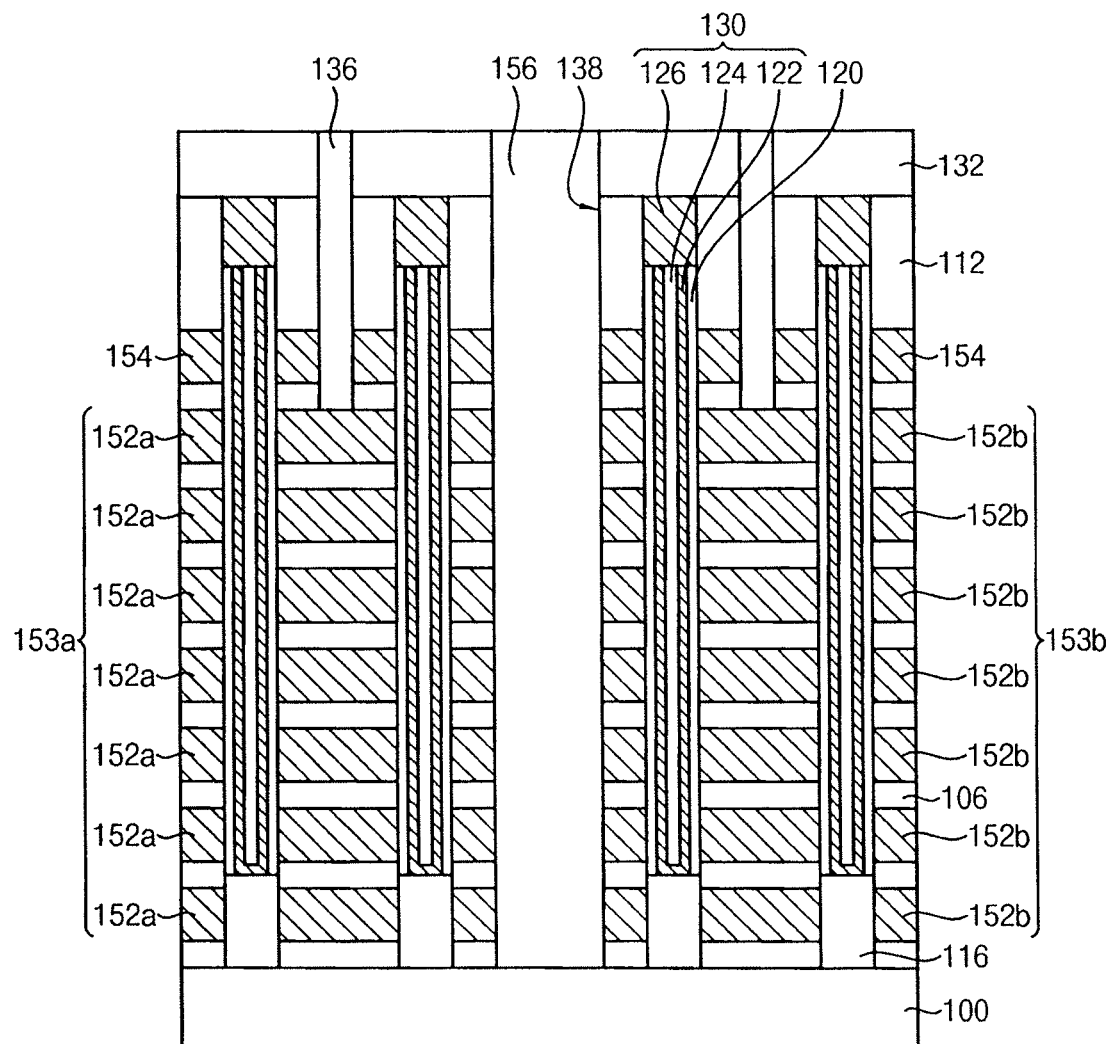


FIG. 3

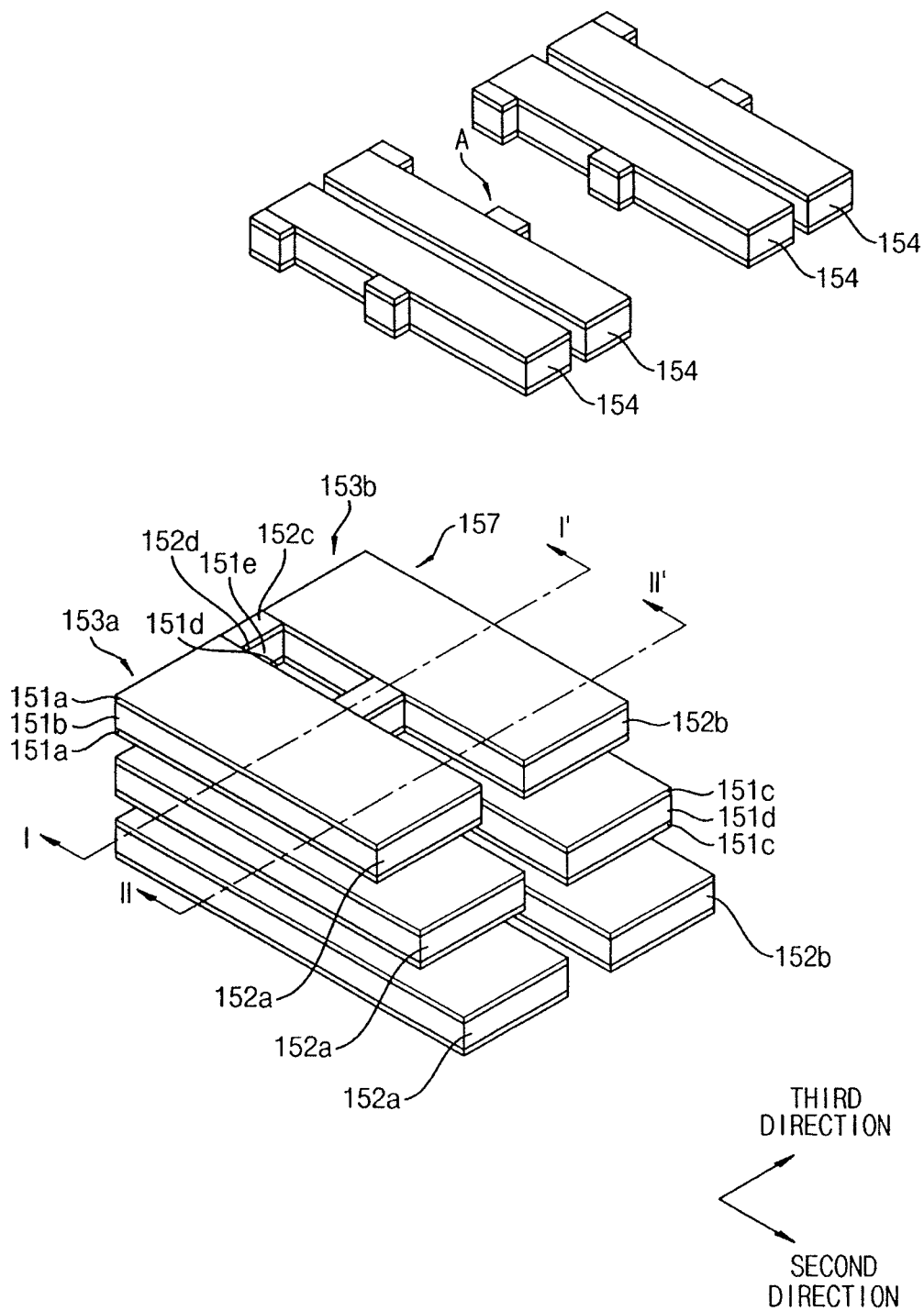
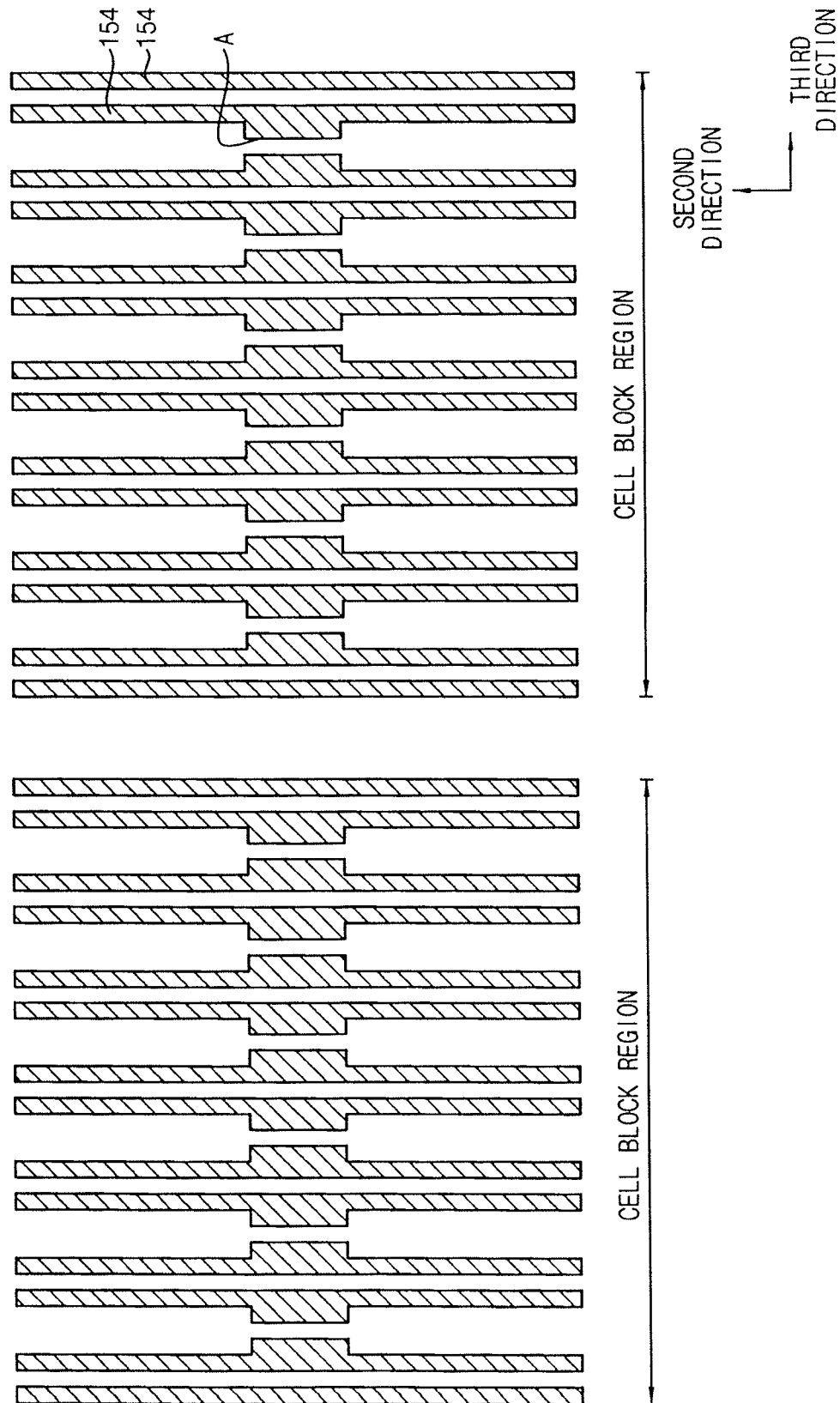


FIG. 4A



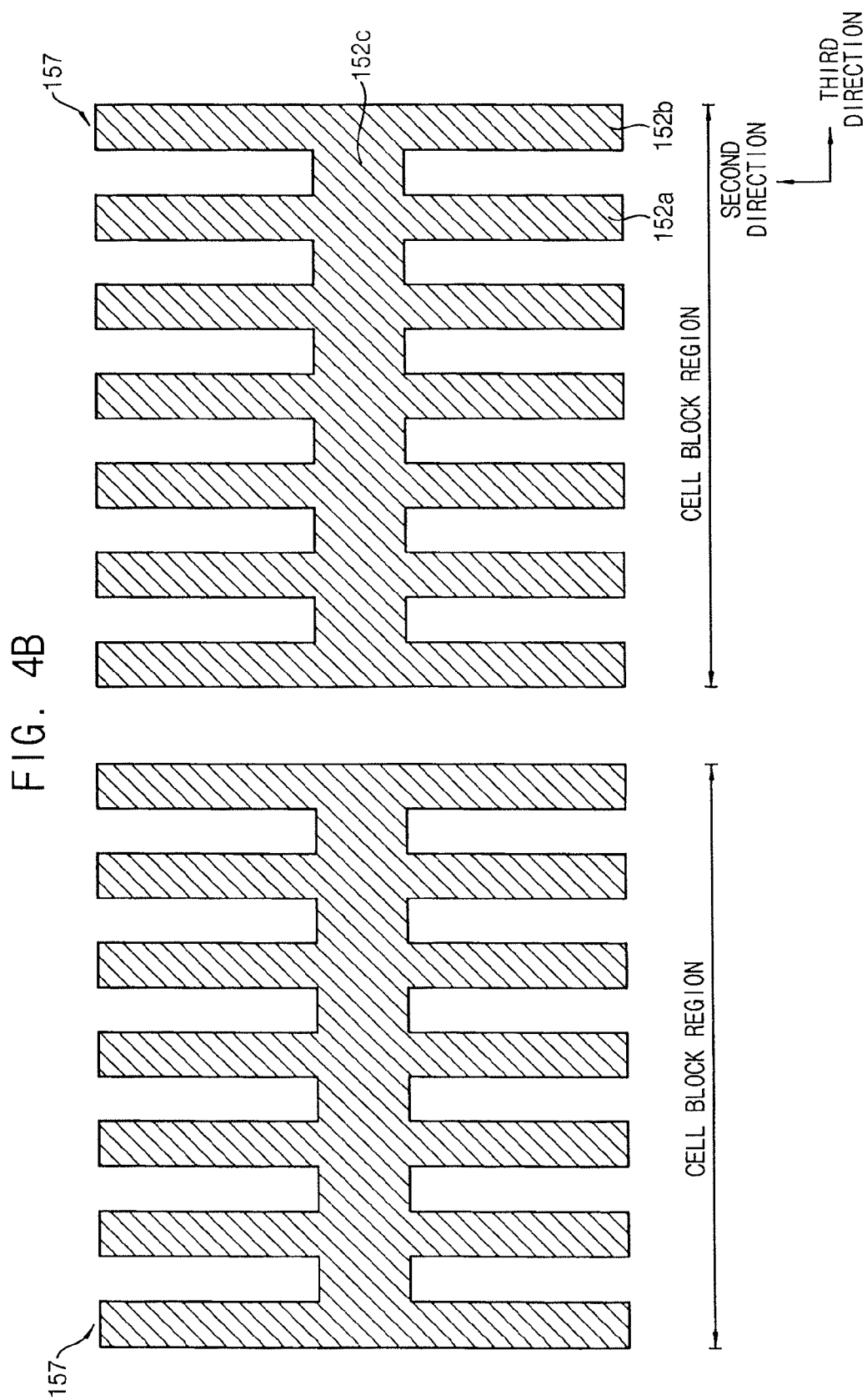


FIG. 5

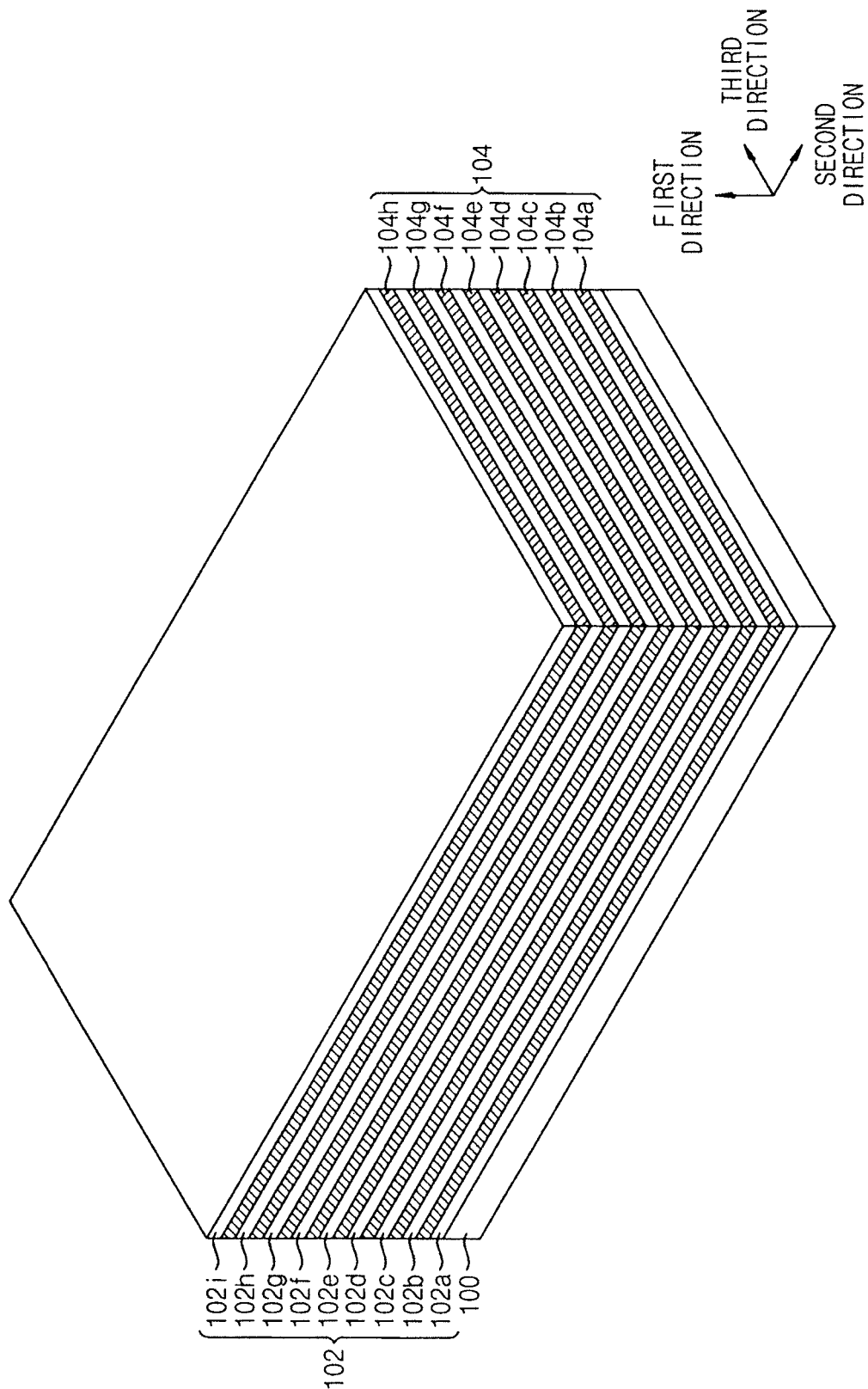


FIG. 6

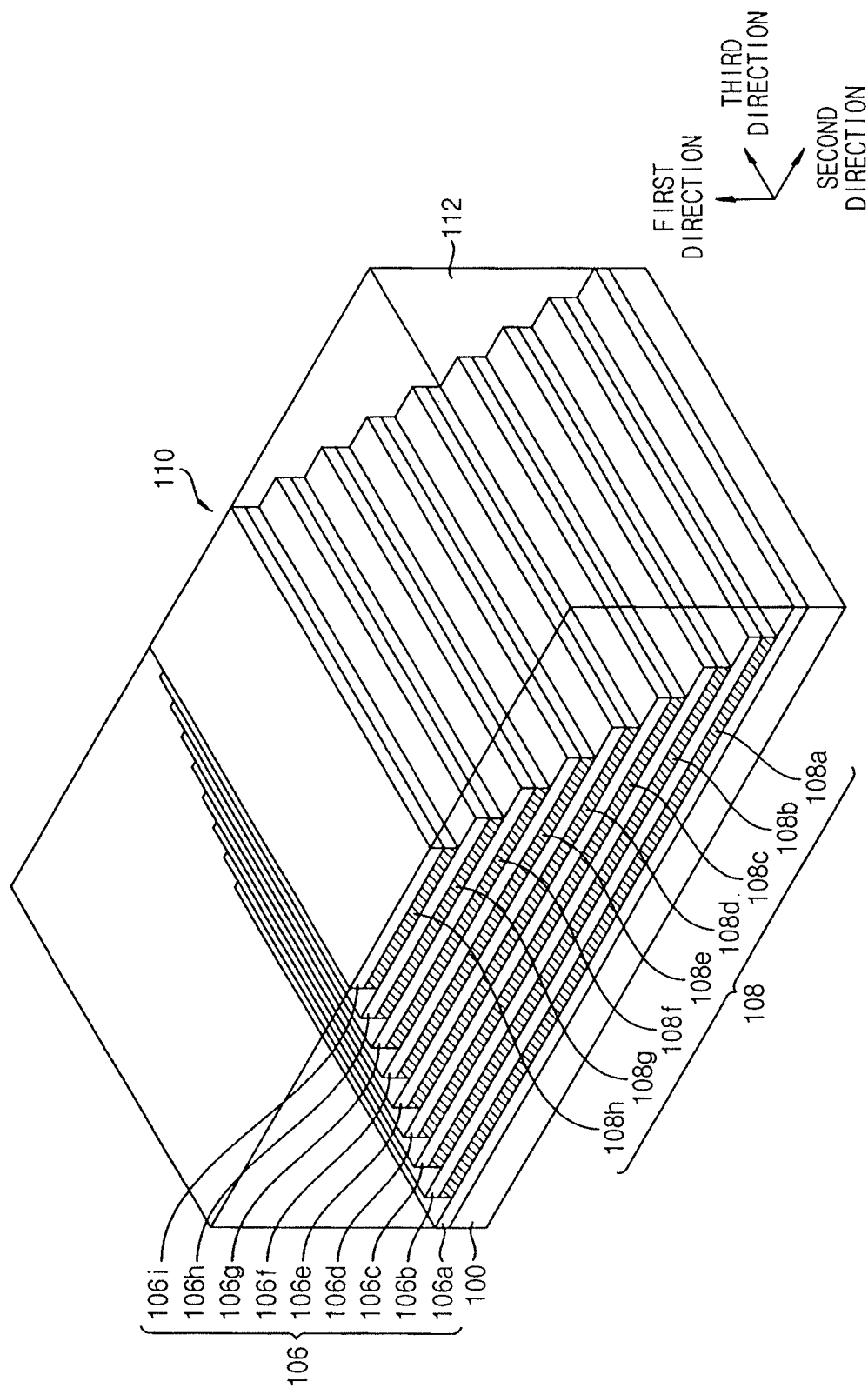


FIG. 7

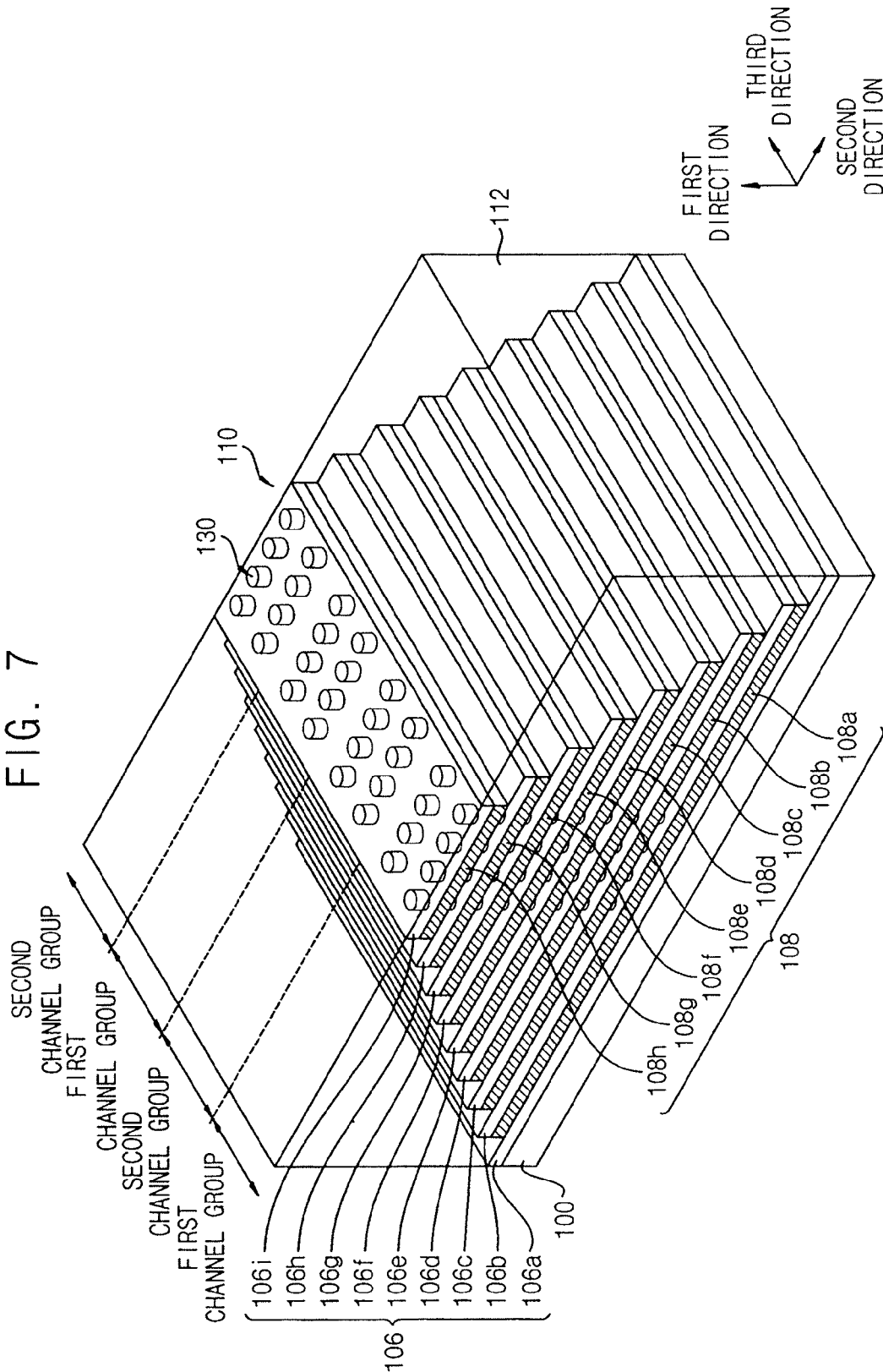
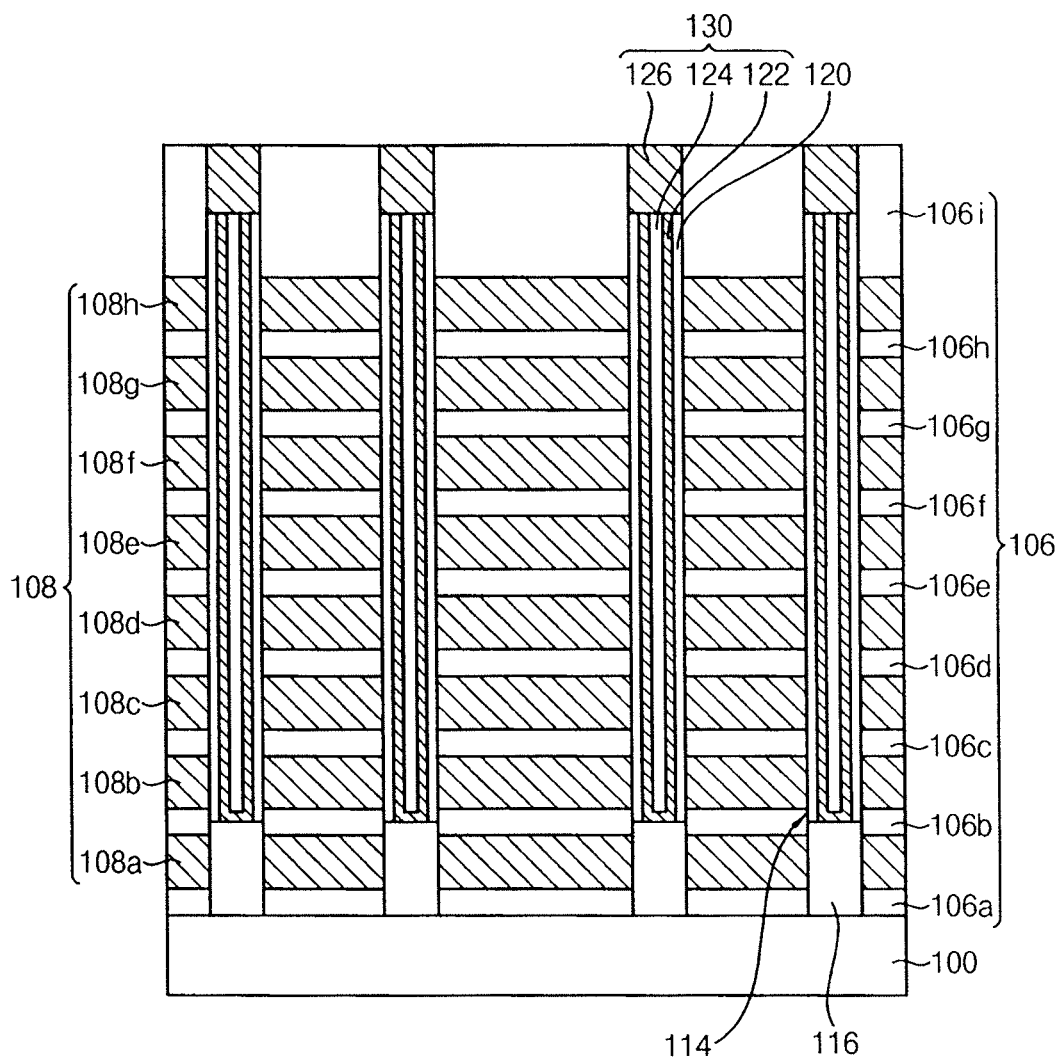


FIG. 8



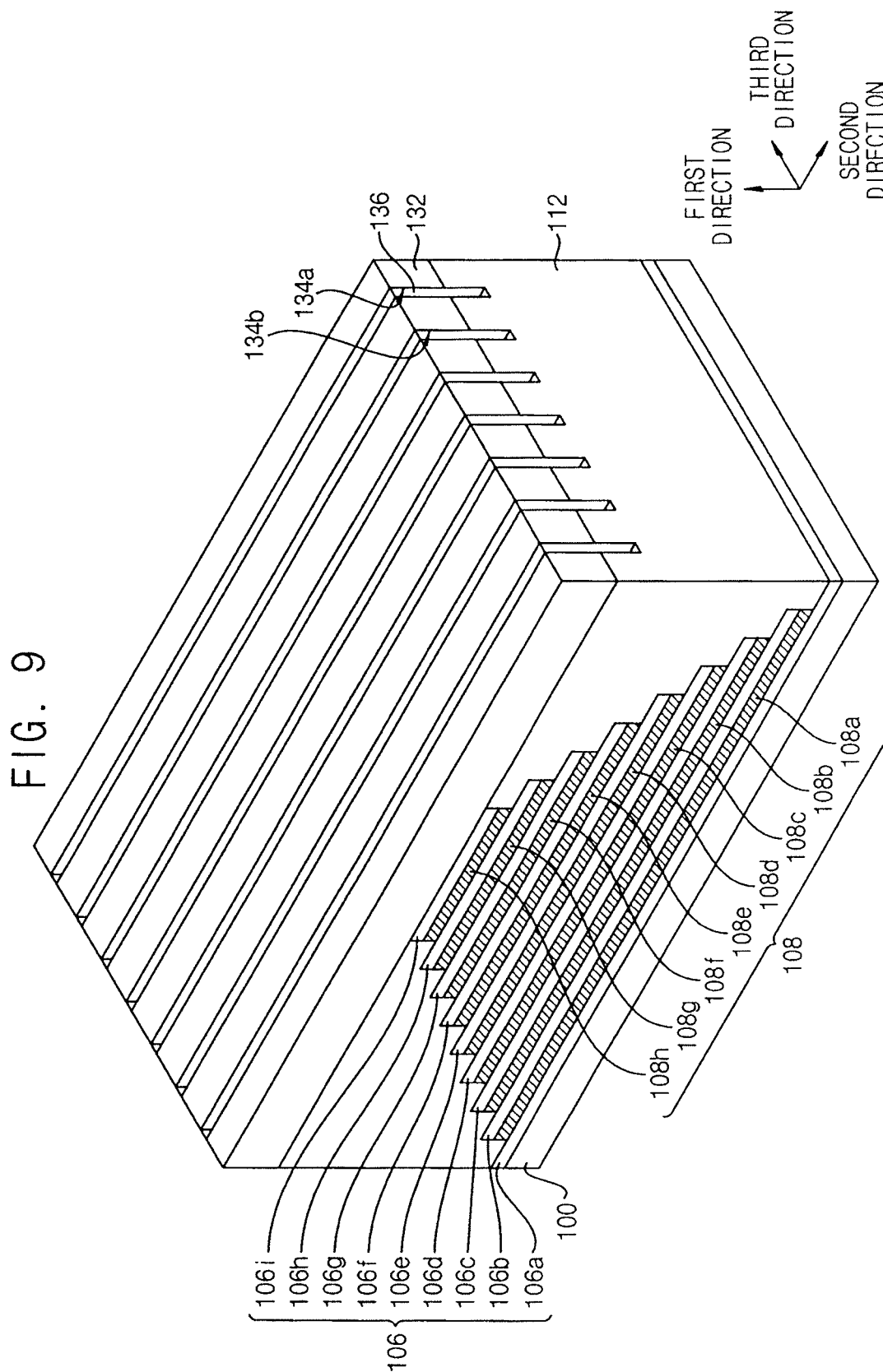


FIG. 10

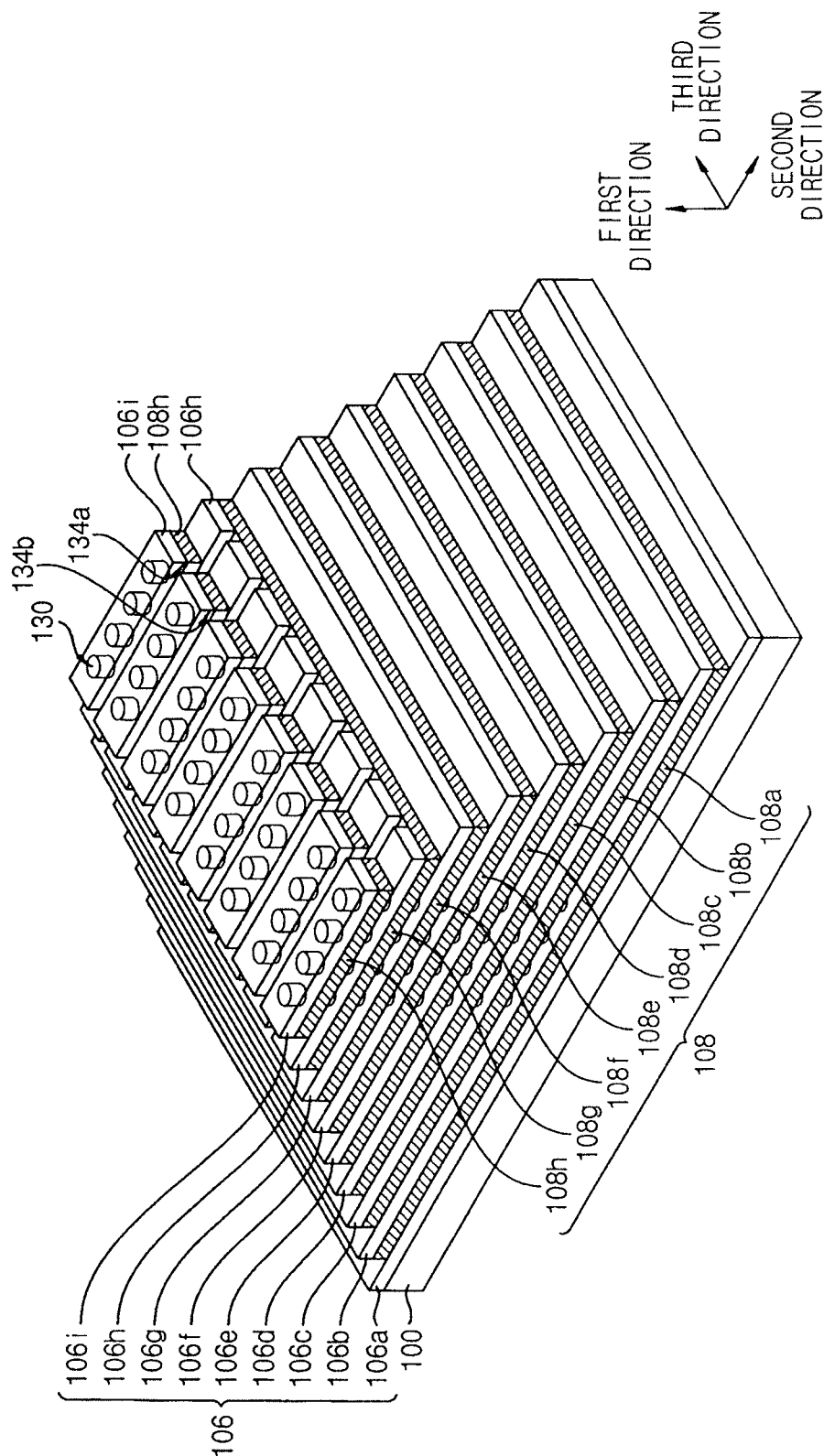


FIG. 11A

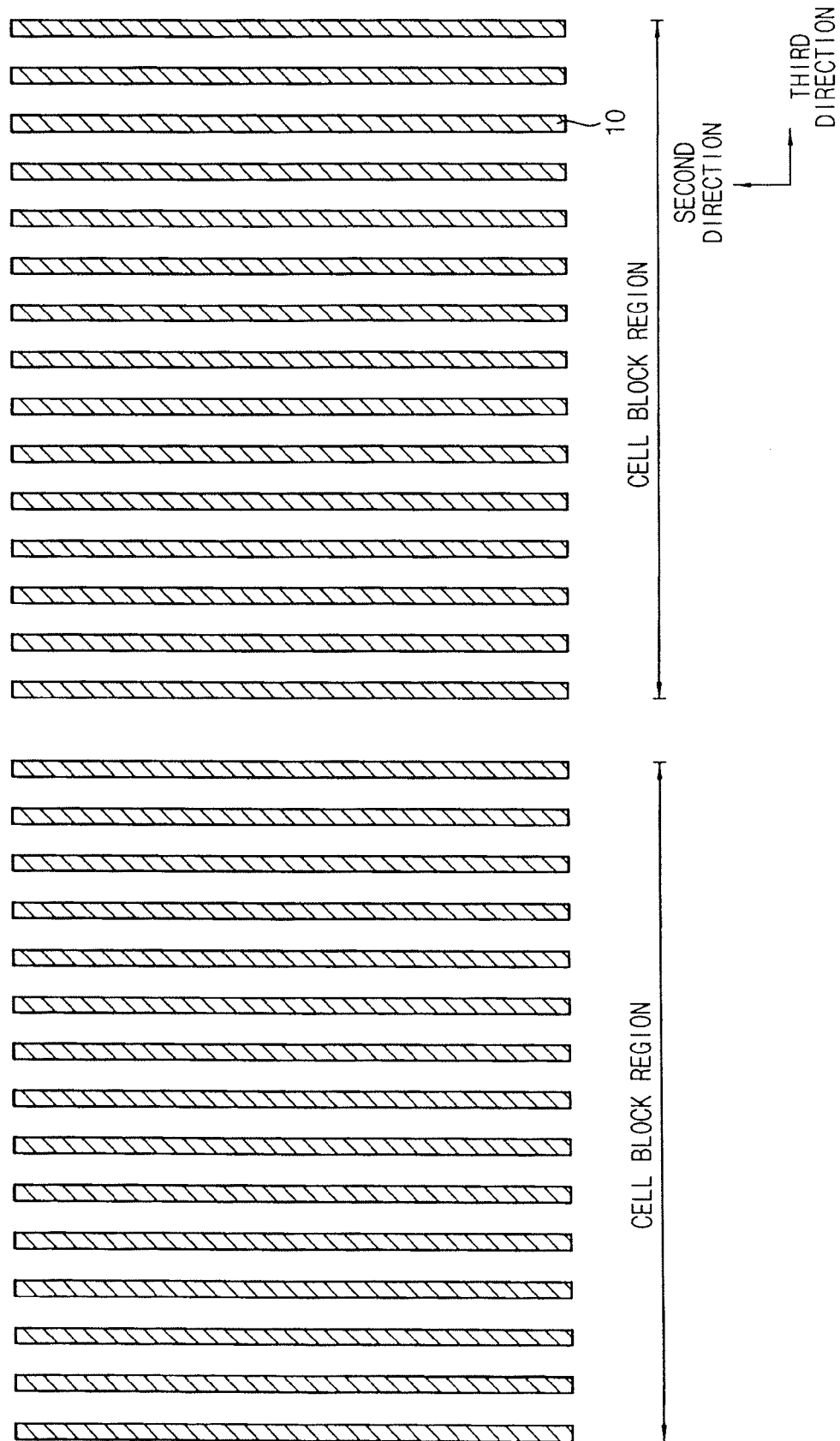


FIG. 11B

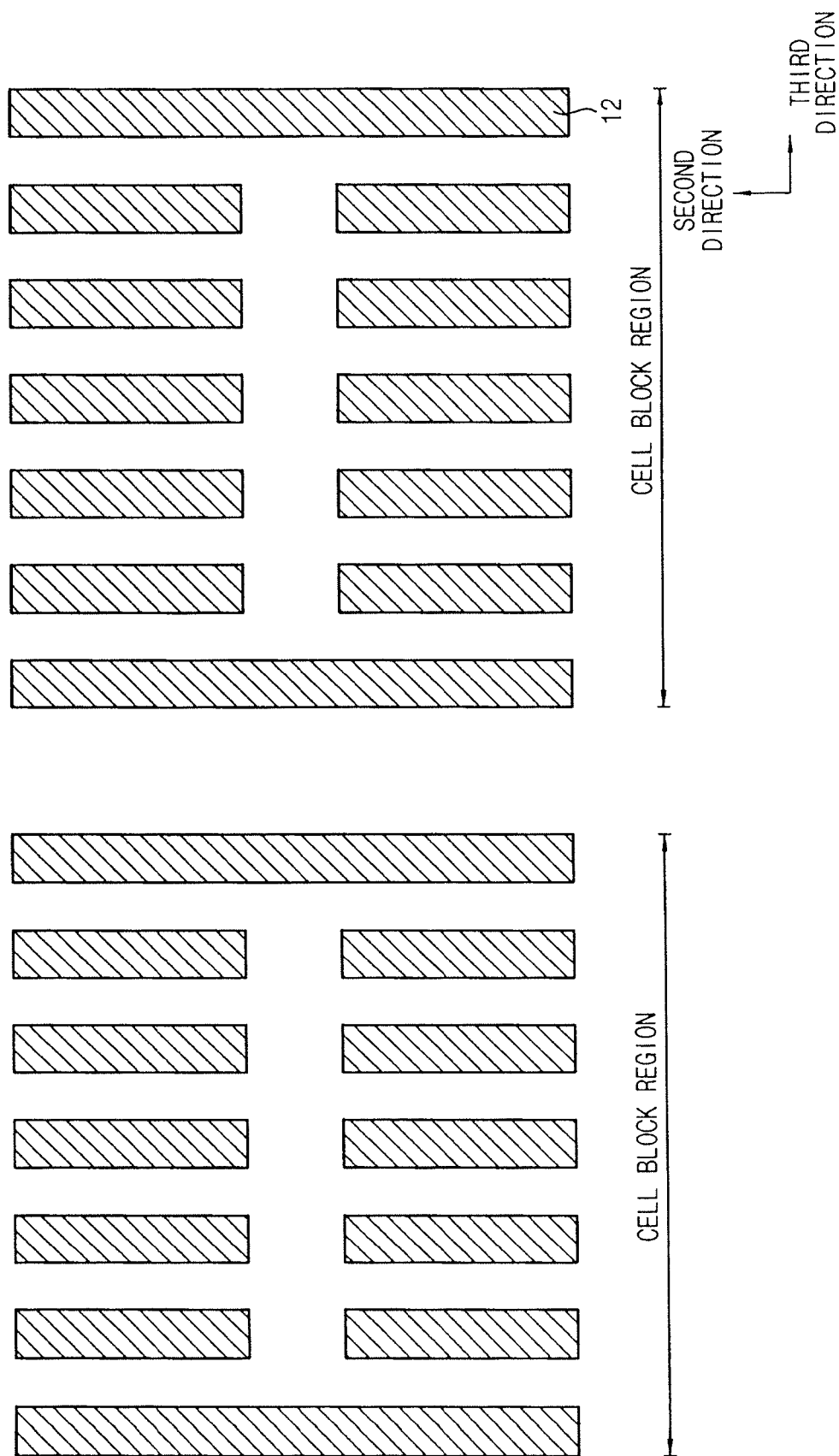


FIG. 12

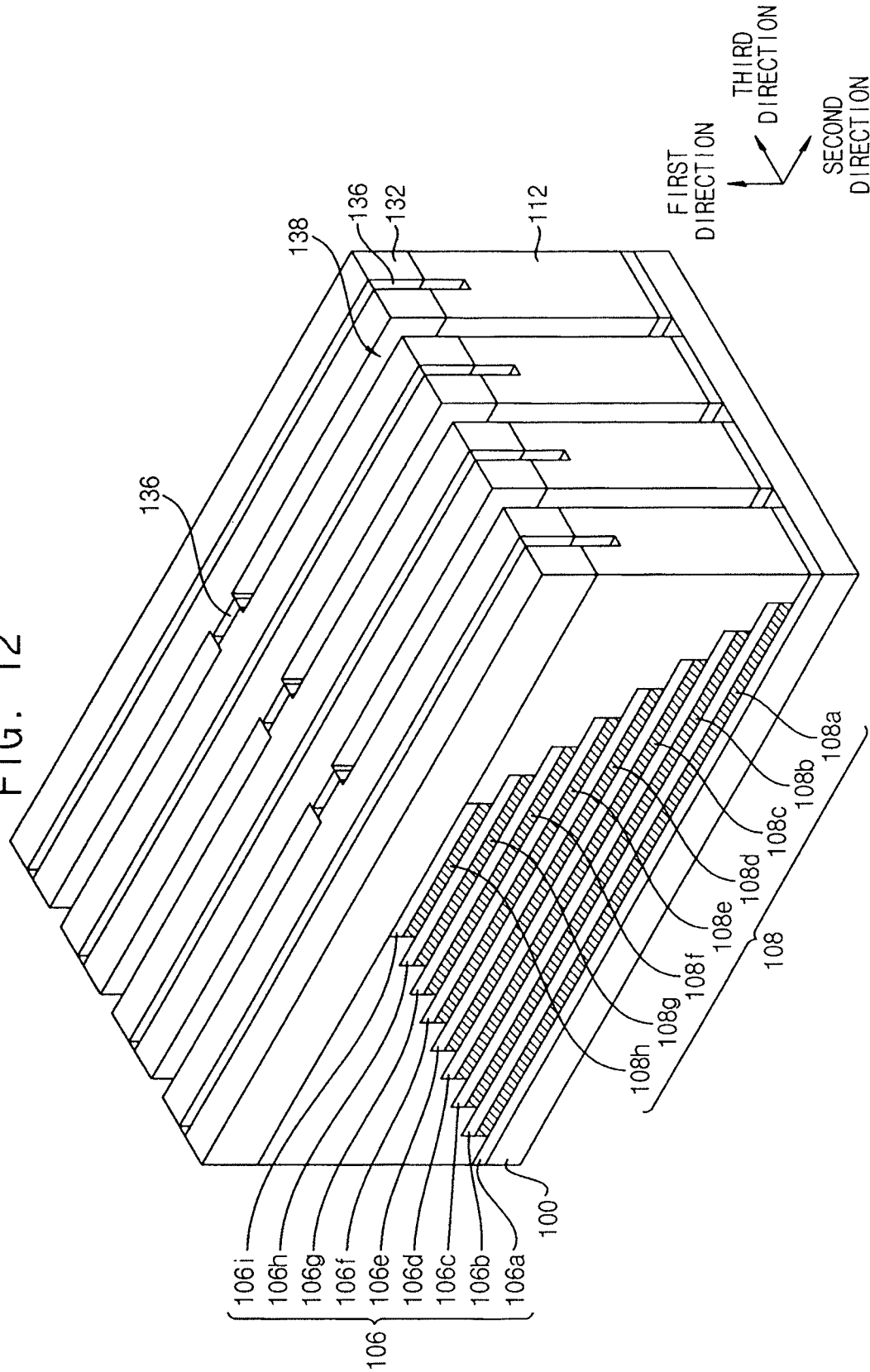


FIG. 13

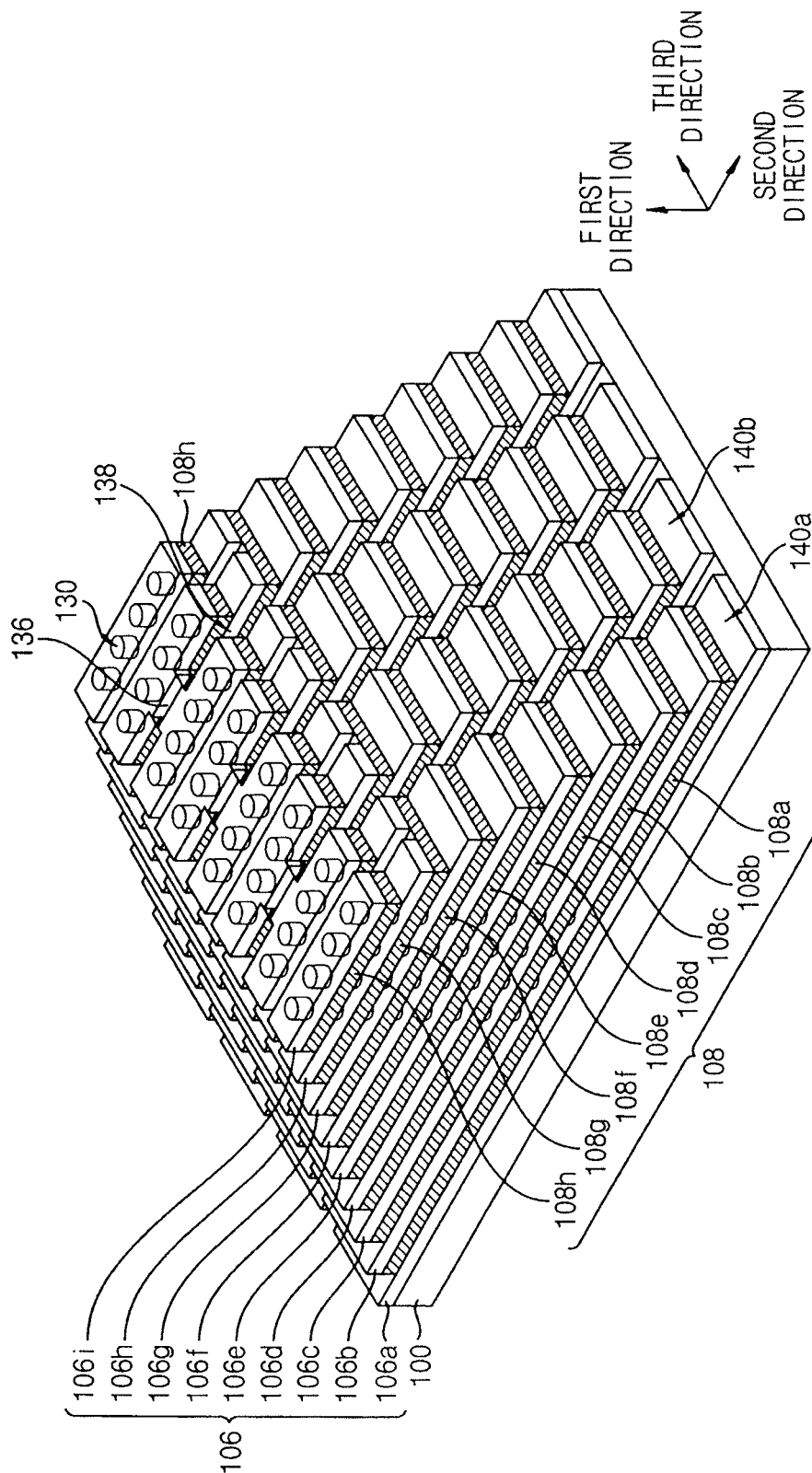


FIG. 14

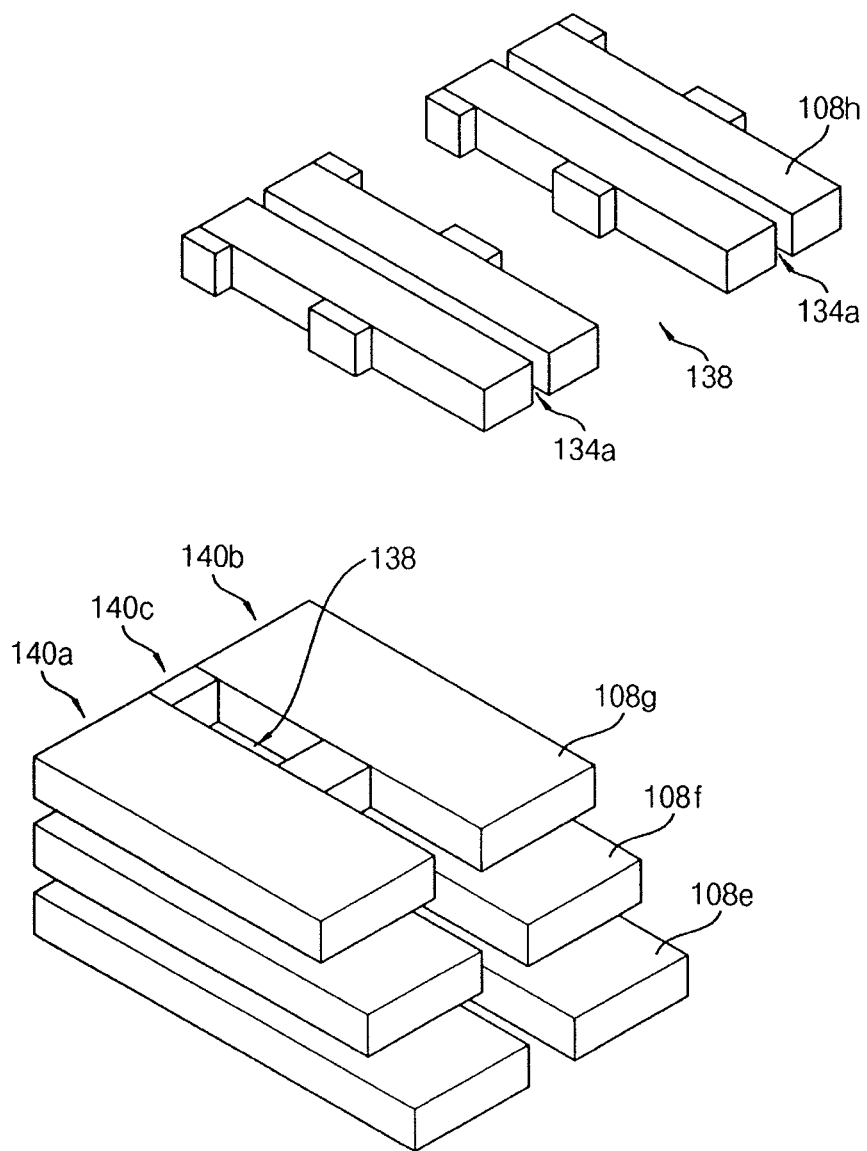


FIG. 15

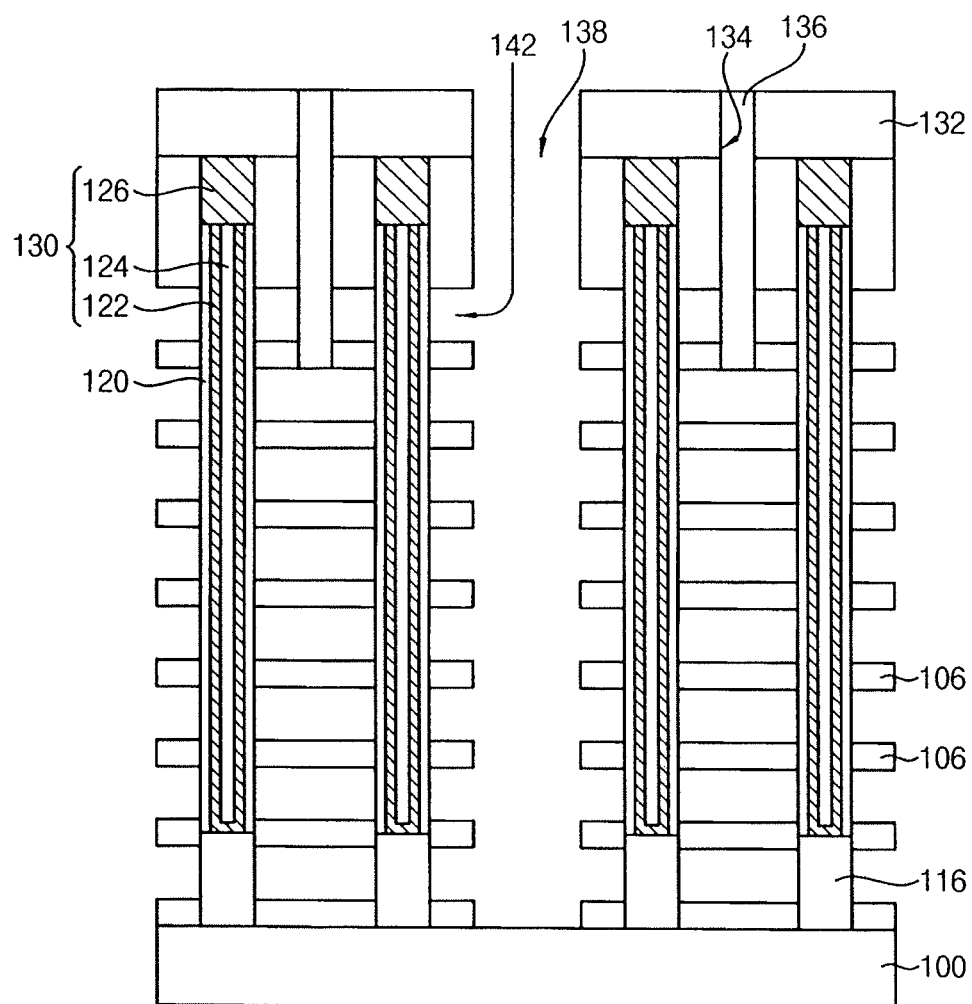


FIG. 16A

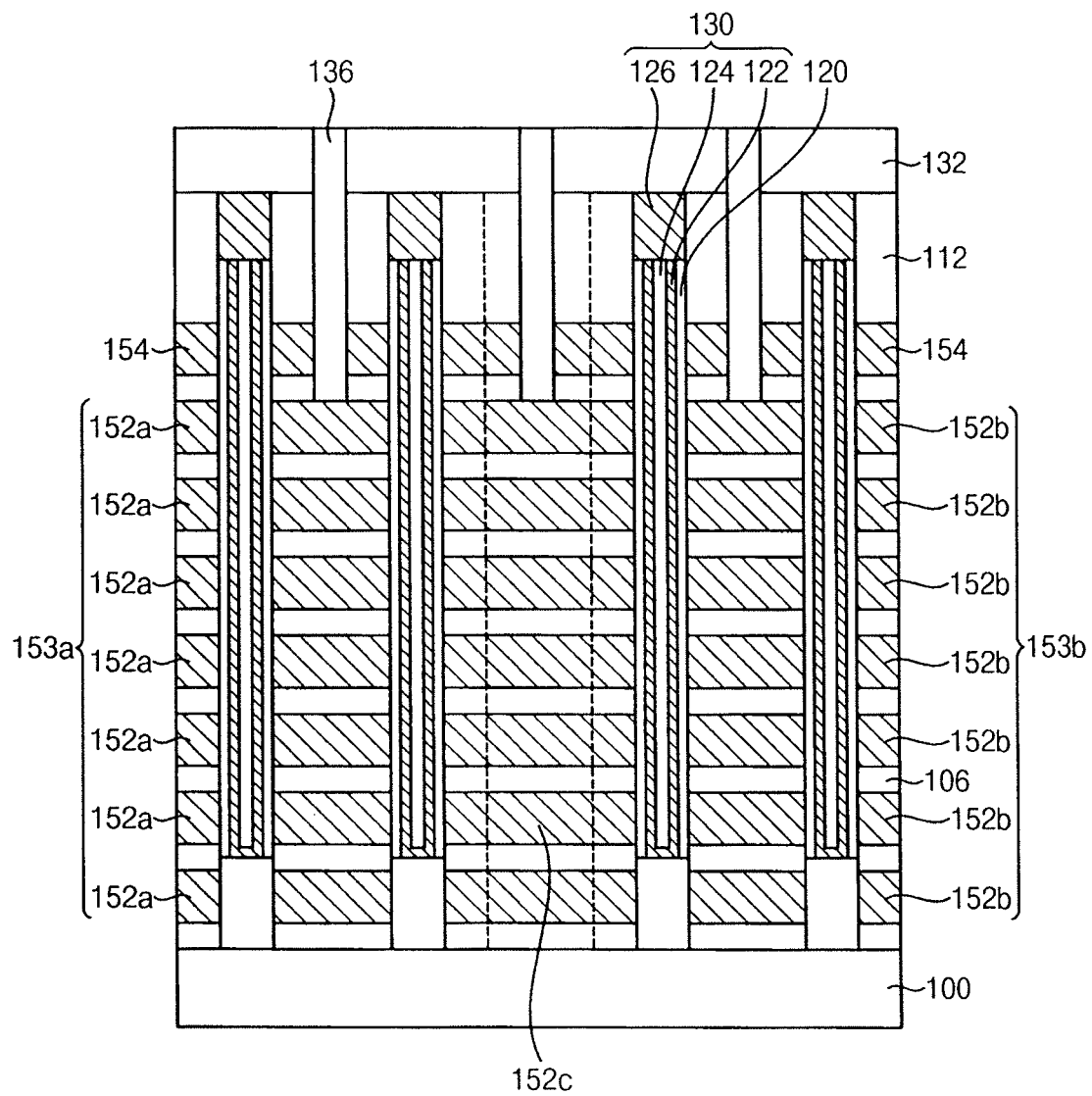


FIG. 16B

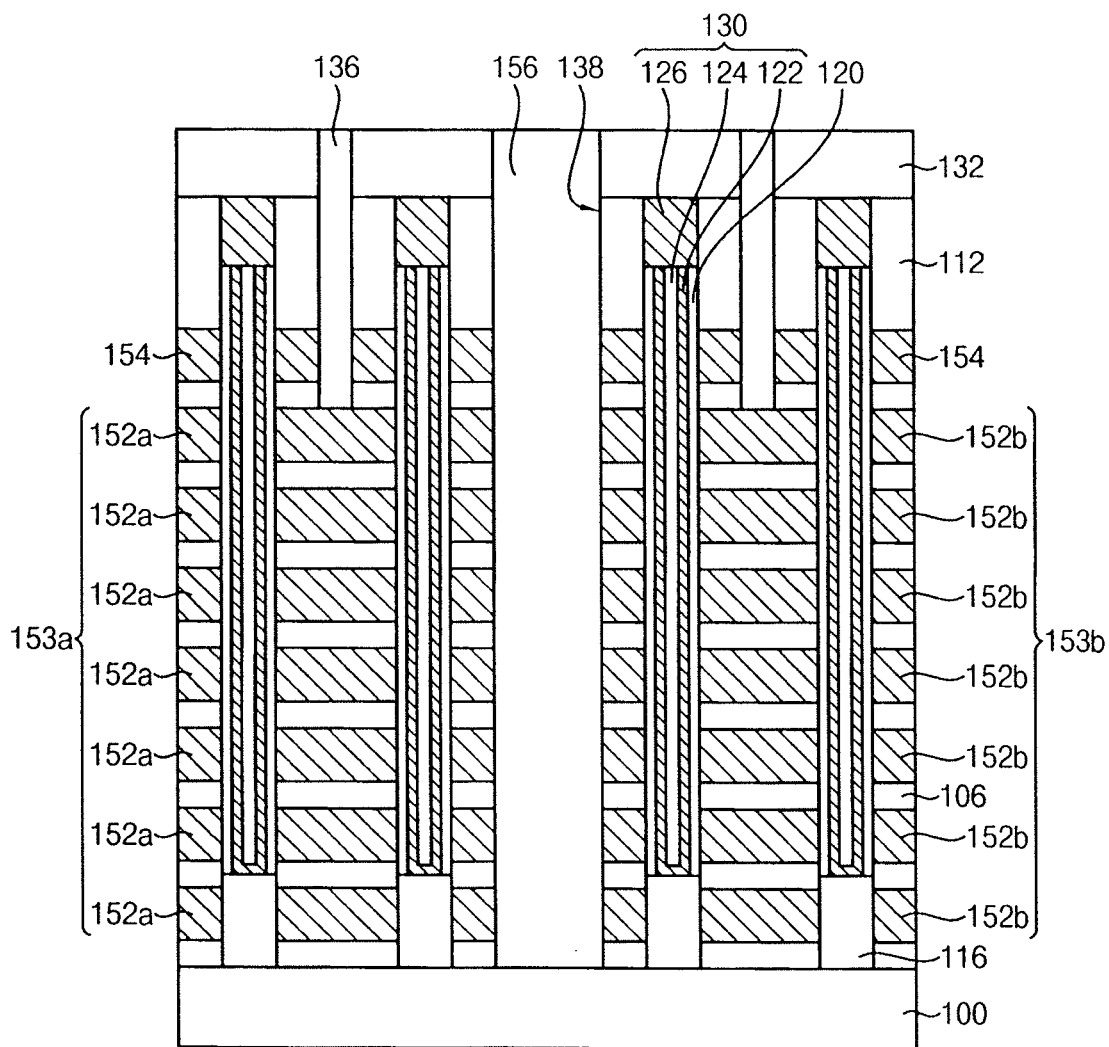
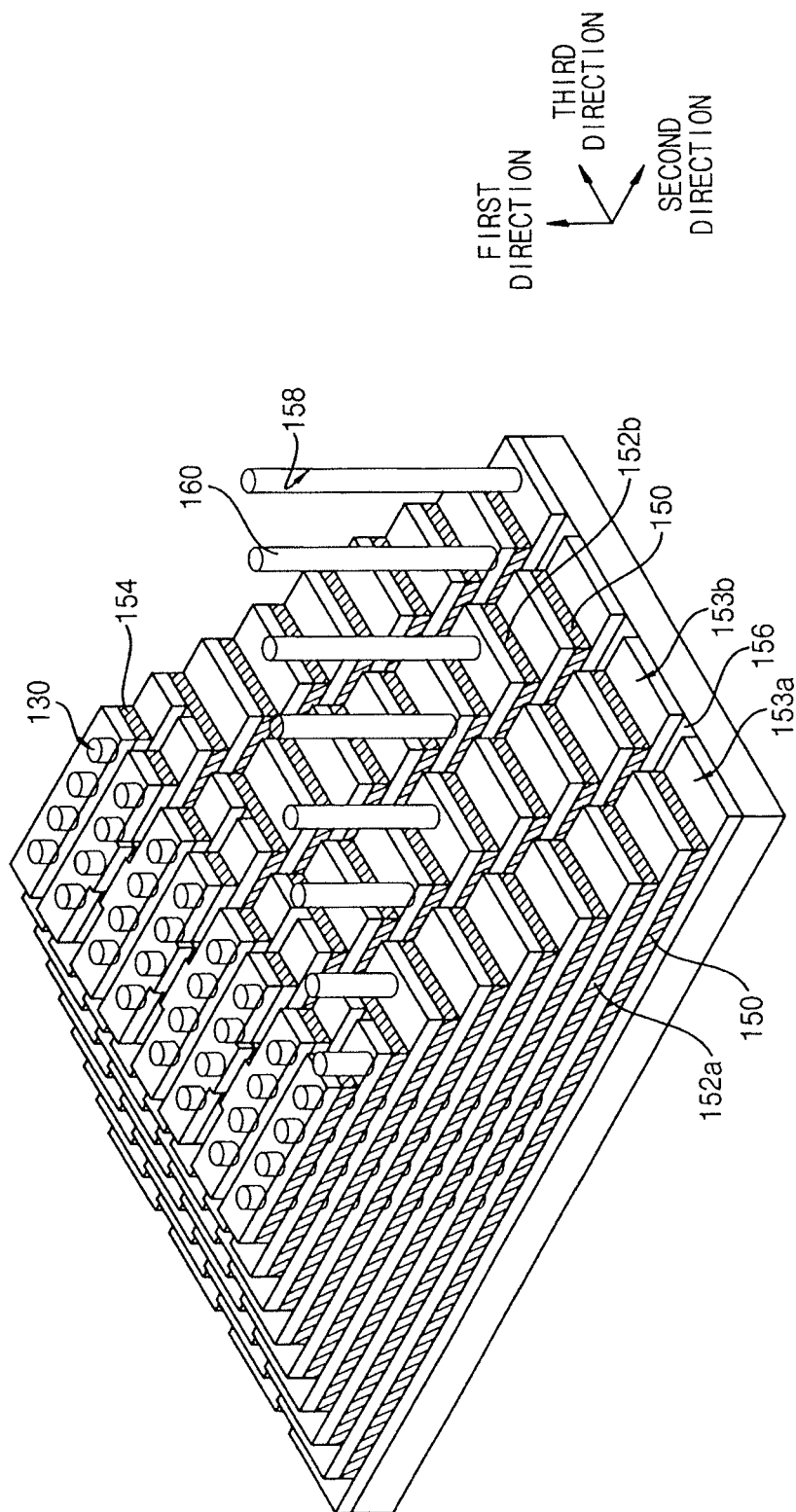


FIG. 17



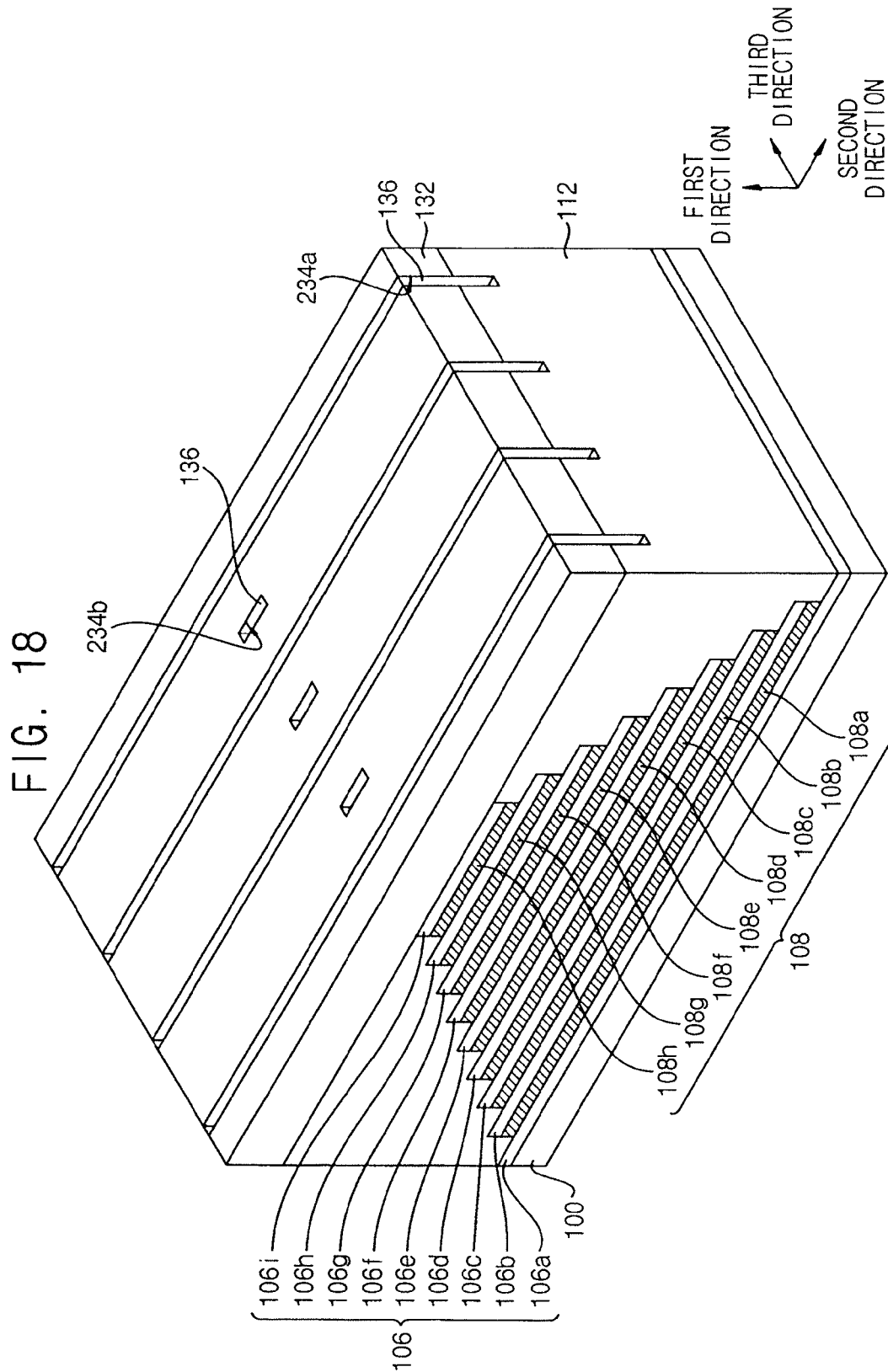
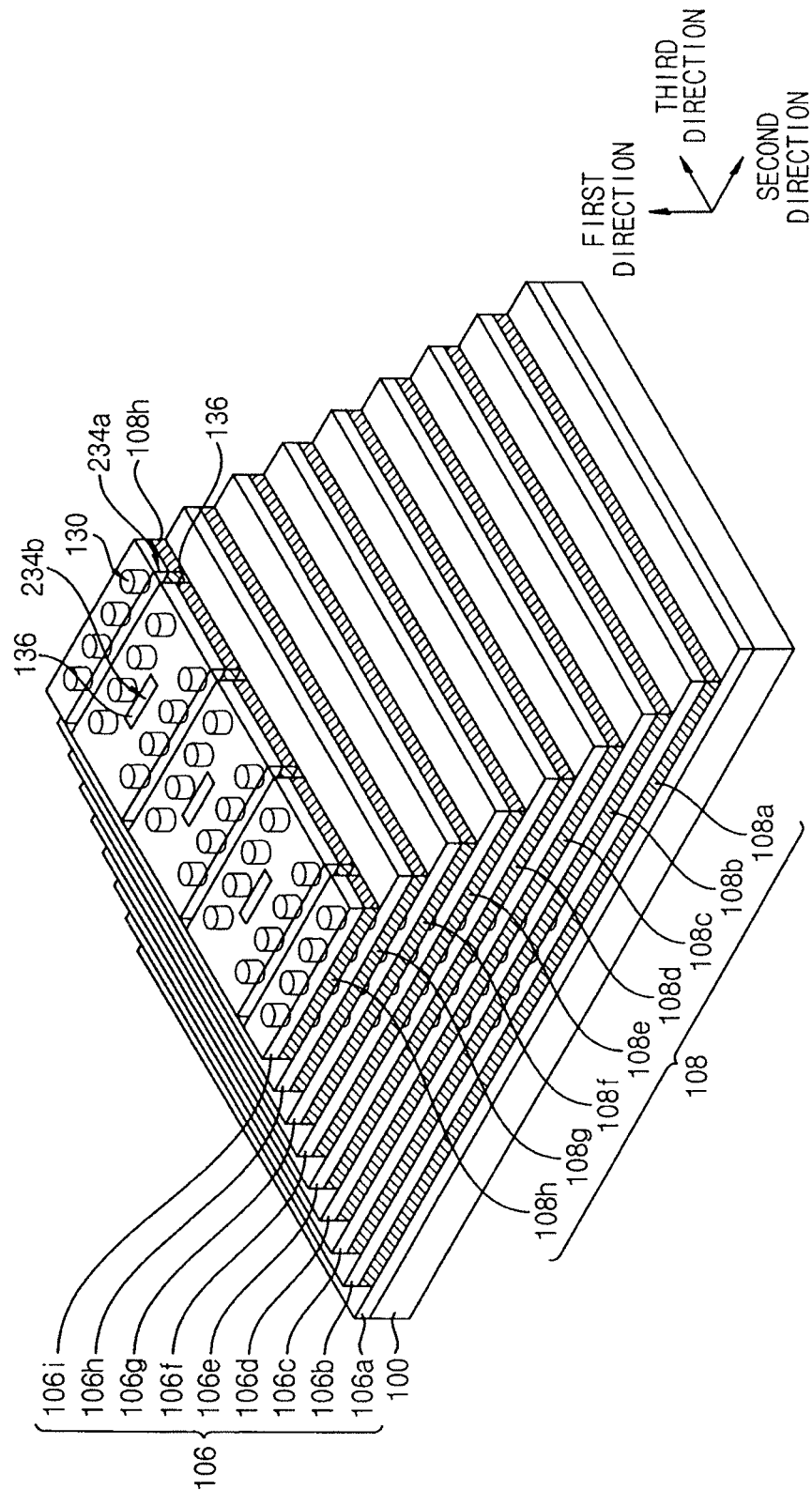


FIG. 19



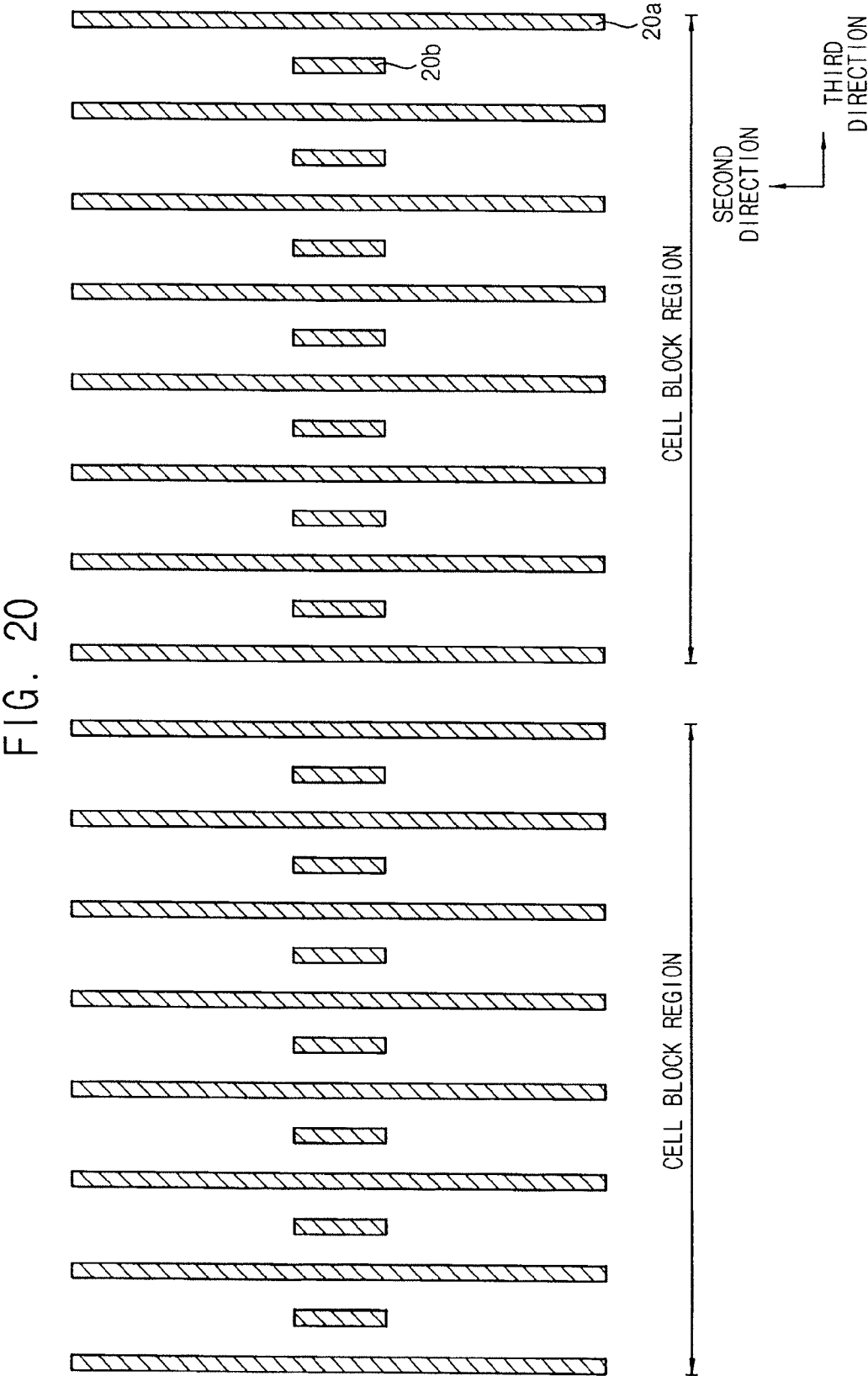


FIG. 21

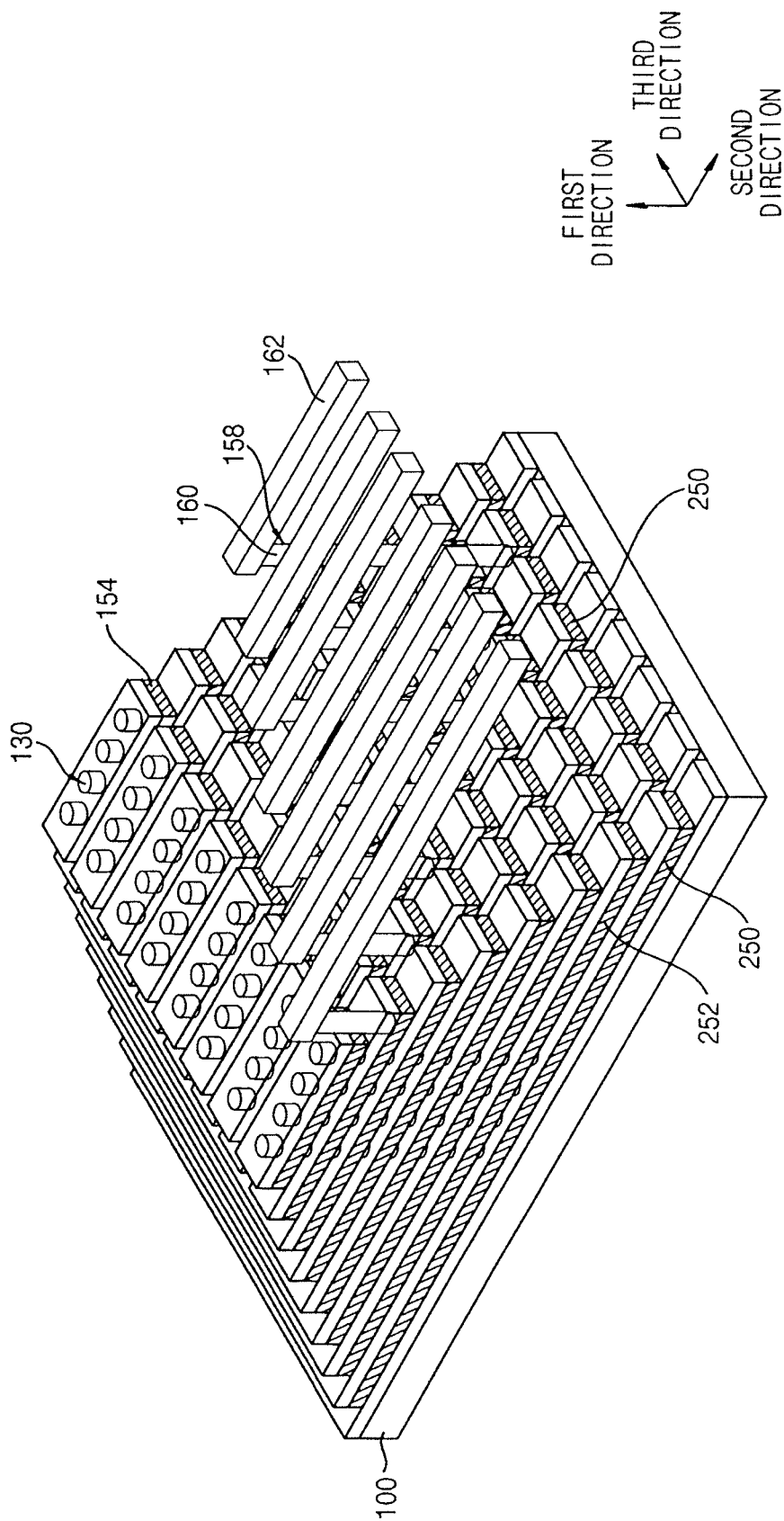


FIG. 22

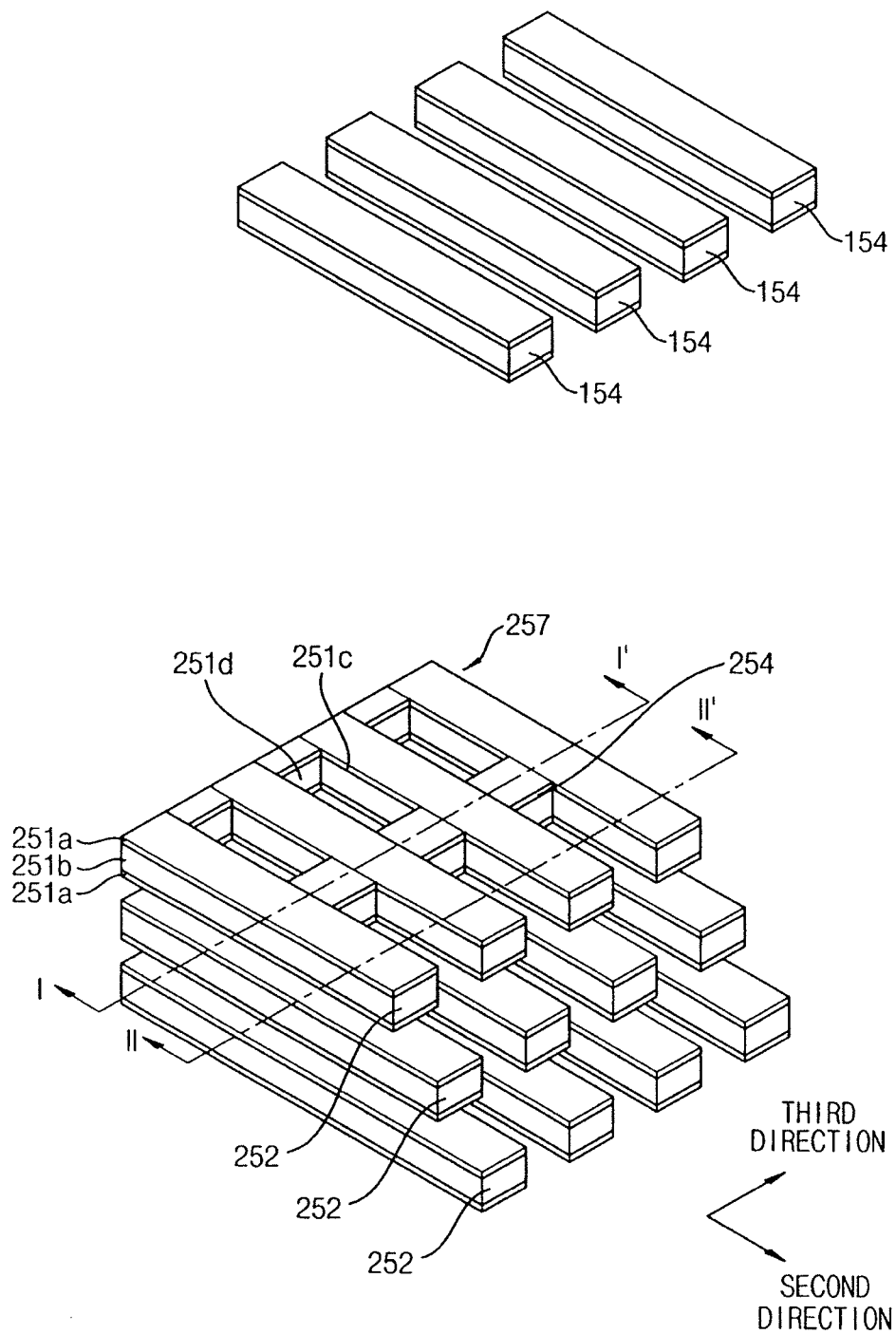


FIG. 23

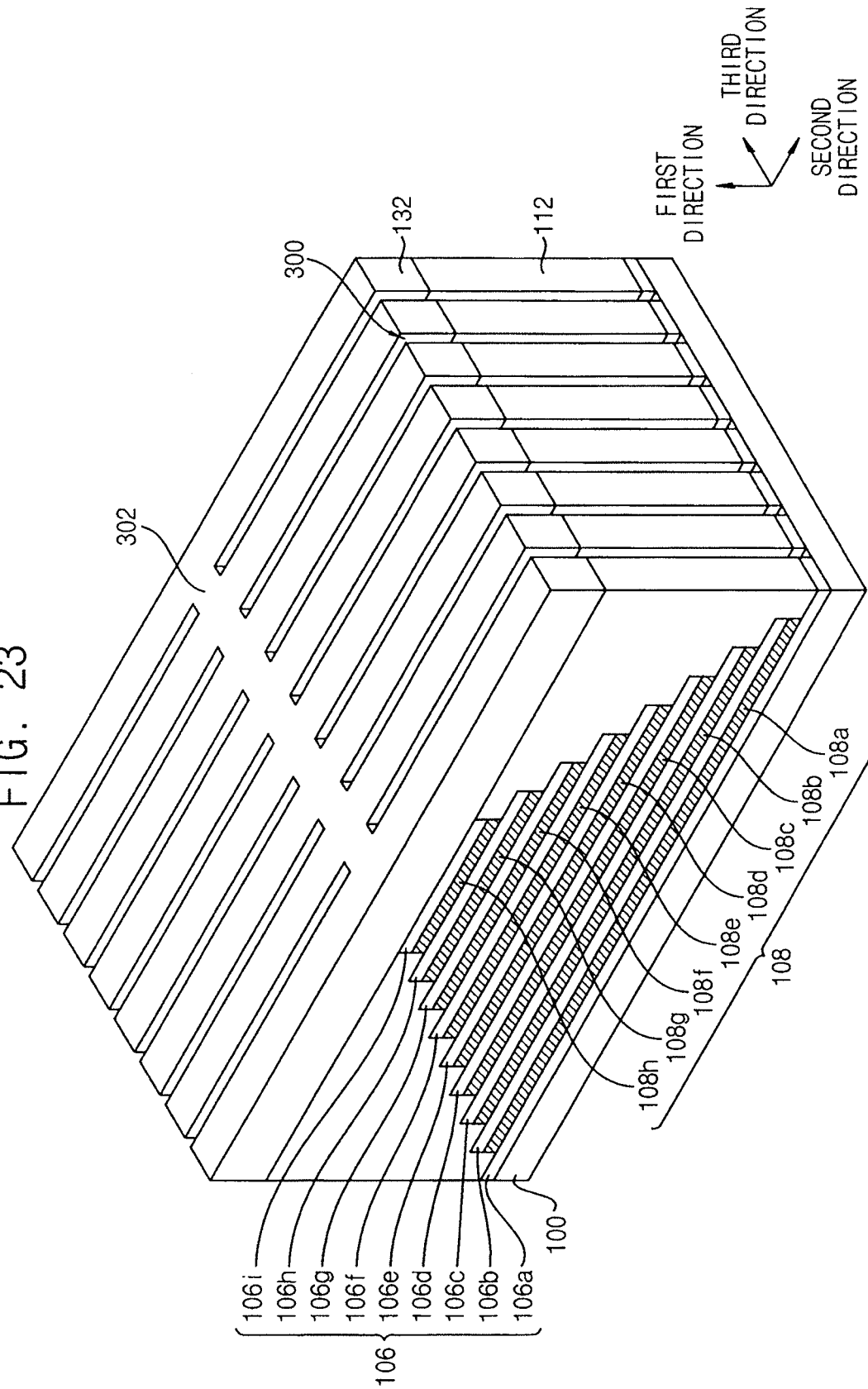
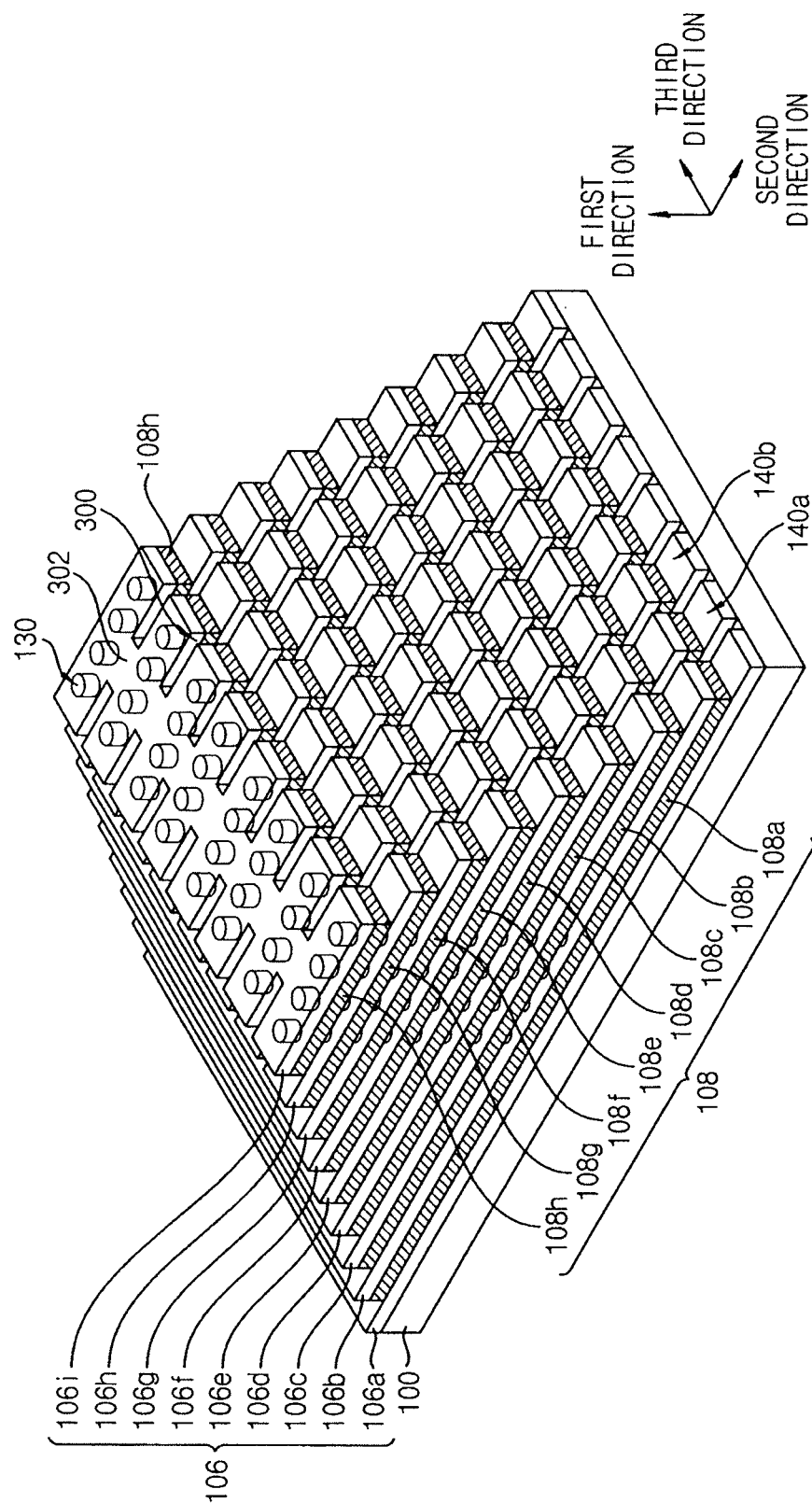


FIG. 24



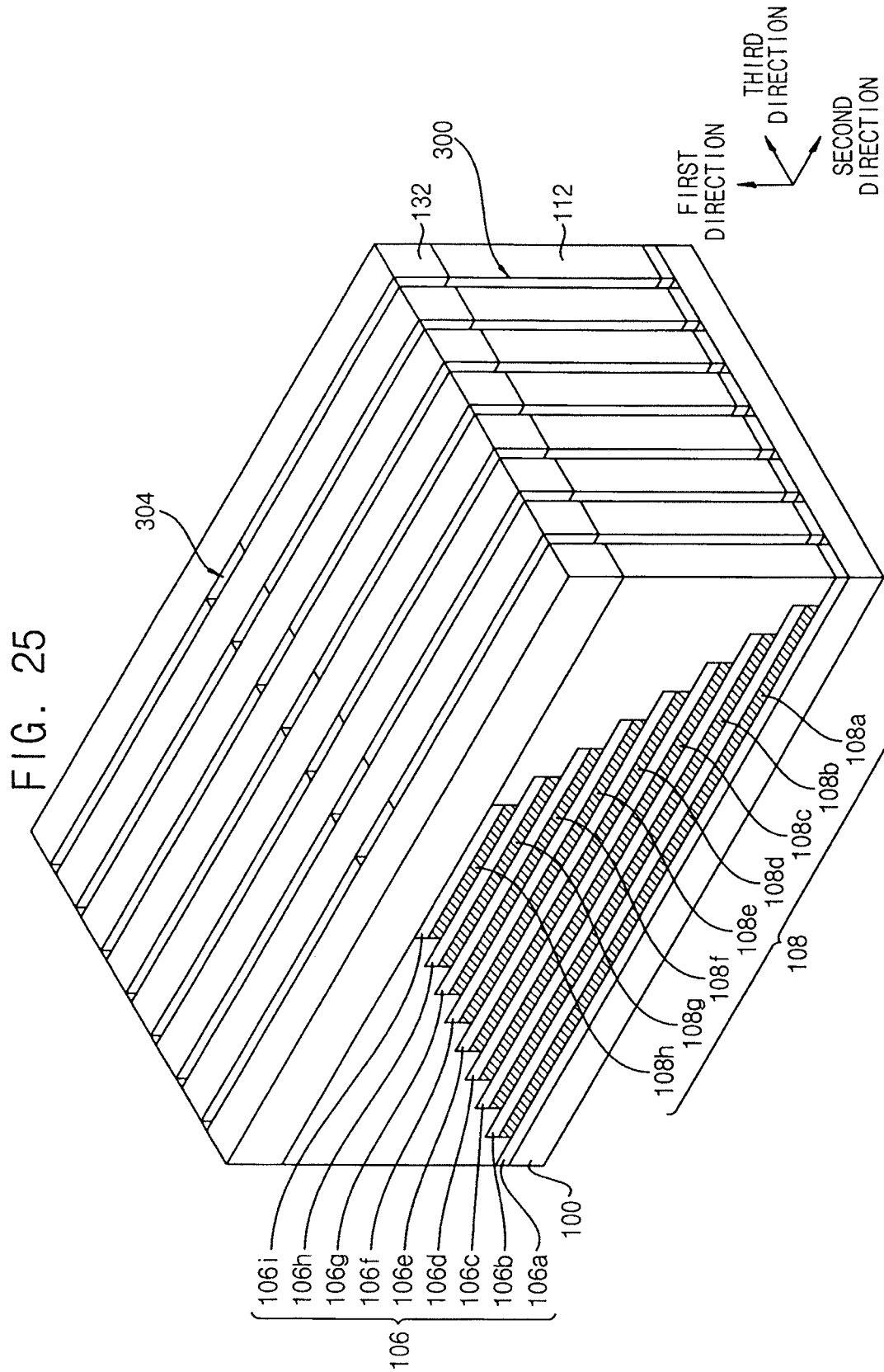


FIG. 26

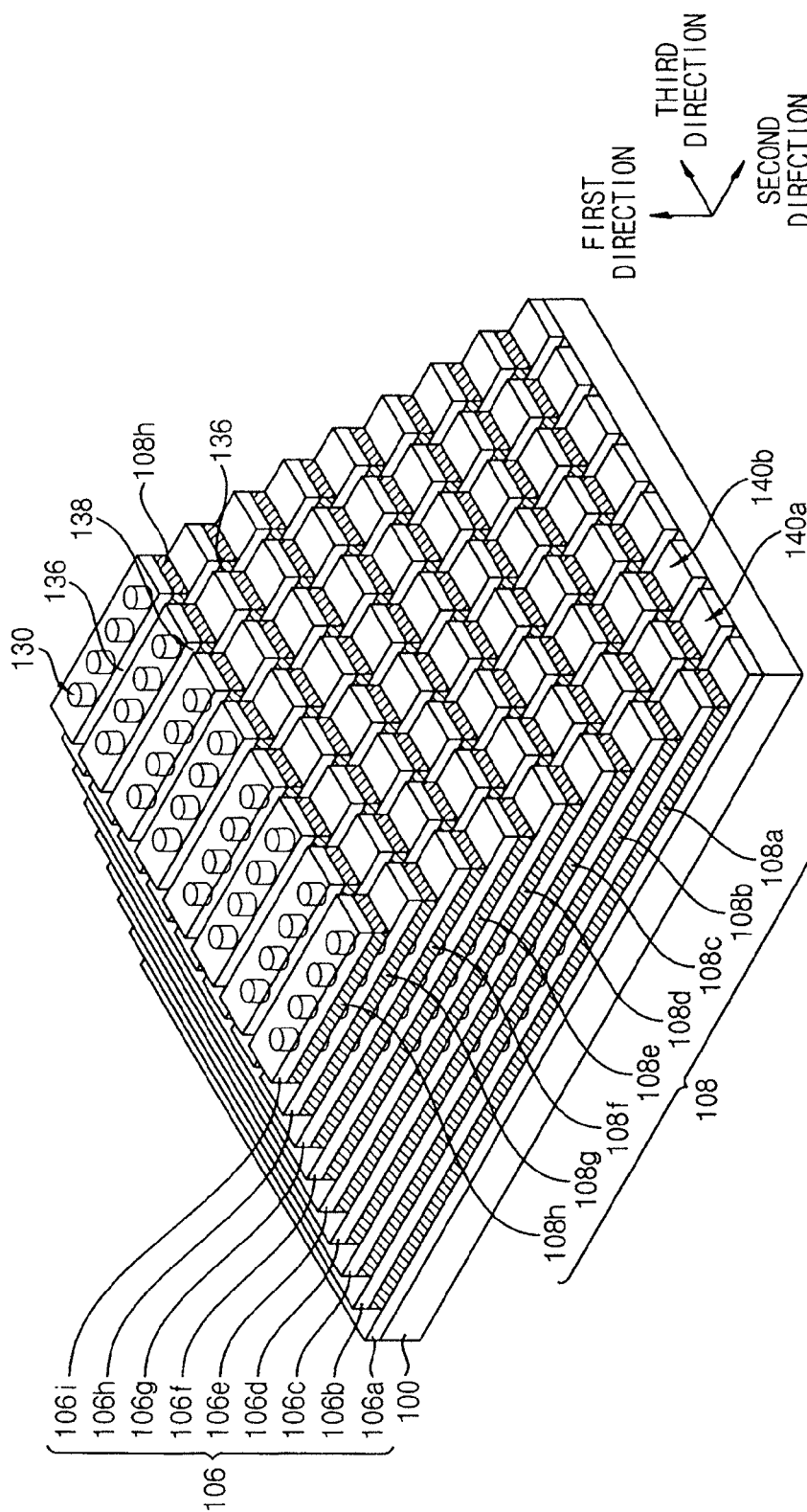
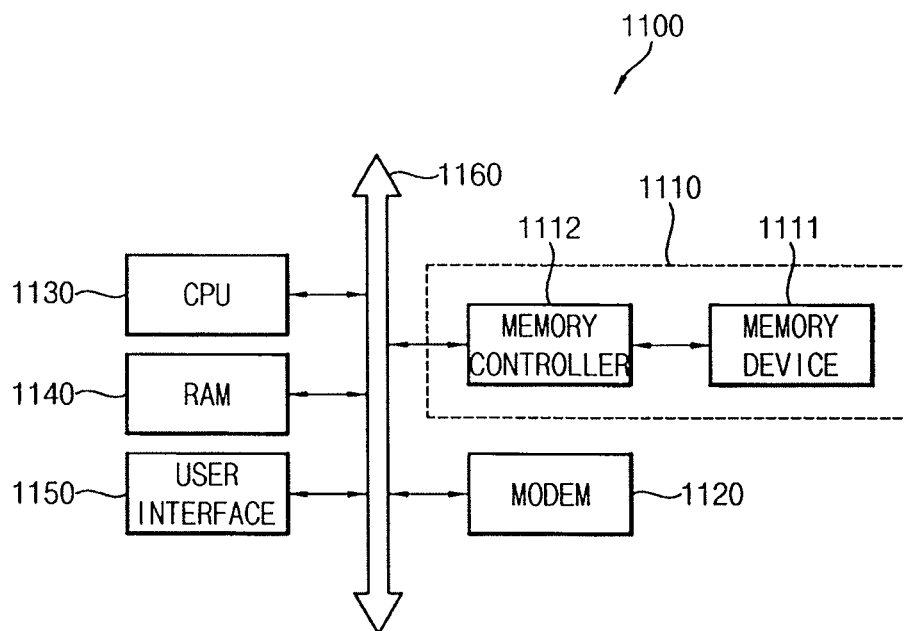


FIG. 27



1

VERTICAL TYPE SEMICONDUCTOR DEVICES

CROSS-REFERENCE TO RELATED APPLICATION

Korean Patent Application No. 10-2013-0005325, filed on Jan. 17, 2013, in the Korean Intellectual Property Office, and entitled, "Vertical Type Semiconductor Devices," is incorporated by reference herein in its entirety.

BACKGROUND

1. Field

One or more embodiments described herein relate to a semiconductor device.

2. Description of the Related Art

Various techniques have been developed for making semiconductor devices. One technique involves stacking cells in a vertical direction on a substrate, for purposes of attaining a higher degree of device integration. In such a device, word lines included in each cell may also have a vertically stacked structure. However, vertically stacking the word lines has been shown to complicate the wiring design used to apply electrical signals to the word lines.

SUMMARY

In accordance with one embodiment, a vertical type semiconductor device includes a plurality of pillar structures extending in a first direction, the pillar structures including channel patterns and being arranged in a second direction and a third direction crossing the second direction; a first word line structure surrounding the pillar structures, the first word line structure extending in the second direction and including first word lines, the first word lines being spaced apart from each other and stacked in the first direction; a second word line structure surrounding the pillar structures, the second word line structure extending in the second direction and including second word lines, the second word lines being spaced apart from each other and stacked in the first direction, the second word line structure being disposed adjacent to the first word line structure in the third direction; a plurality of connecting patterns to connect side walls of adjacent first and second word lines, the connecting patterns being electrically coupled with the first and second word lines positioned at a same level; and a plurality of string select lines coupled to string select transistors on the first and second word line structures, each of the string select lines surrounding at least one pillar structure in the third direction and extending in the second direction, and the pillar structures having a shape separate from shapes of the first and second word line structures.

Also, the first and second word lines and the connecting patterns are positioned at the same level correspond to word line patterns, and the word line pattern in one layer is connected with one contact plug and one connecting wiring electrically coupled to the contact plug.

Also, the word line patterns are arranged in a block unit and wherein the first and second word lines positioned in a block region of the block unit are electrically connected. The connecting patterns at each layer face the first direction.

Also, a ground select transistor may include a ground select line under the first and second word lines at a lowest layer.

Also, the first and second word lines extend to surround at least one pillar structure in the third direction. The first and second word lines may be wider than the string select line.

2

The first and second word lines may have substantially a same line width as the string select line. The connecting pattern may include a same conductive material as the first and second word lines.

Also, the conductive material comprises a barrier metal material including a metal nitride and a metal material including tungsten.

Also, a portion of the string select line facing the connecting pattern in the first direction is wider than another portion of the string select line.

Also, a plurality of stacked layer structures, wherein each stacked layer structure includes a tunnel insulating layer pattern, a charge storing layer pattern, and a blocking layer pattern arranged on a side wall of a corresponding one of the pillar structures.

In accordance with another embodiment, a vertical type semiconductor device includes a plurality of pillar structures extending in a first direction, the pillar structures including a channel pattern and being arranged in a second direction and a third direction crossing the second direction; a word line pattern including word lines and connecting patterns, the word lines surrounding the pillar structures, extending in the second direction, and being repeatedly arranged in parallel in the third direction, the connecting patterns connecting side walls of the word lines to electrically connect the word lines repeatedly arranged in parallel to each other in the third direction; and a plurality of string select lines coupled to respective string select transistors, each of the string select lines extending in a second direction and provided higher than an uppermost word line pattern and surrounding one pillar structure in the third direction, the string select lines have a shape separate from the word line pattern.

Also, a plurality of the word line patterns are stacked and spaced apart from each other in the first direction. One word line pattern of one layer is provided with one contact plug and a connecting wiring electrically coupled to the contact plug.

In accordance with another embodiment, a vertical type semiconductor device includes a first word line, a second word line, a connector to electrically connect the first word line and the second word line to form a word line pattern; at least one string select line over the word line pattern; and a number of pillars to electrically connect the at least one string select line to the first and second word lines of the word line pattern, wherein the connector is substantially coplanar with the first and second word lines.

Also, at least two pillars pass through the first word line and at least two pillars pass through the second word line. Alternatively, only one pillar passes through each of the first word and the second word line.

Also, a plurality of the word line patterns may be included in a stacked arrangement, wherein ends of the stacked word line patterns are stepped in a predetermined direction. Widths of each of the first word line and the second word line are different from a width of the string select line.

BRIEF DESCRIPTION OF THE DRAWINGS

Features will become apparent to those of ordinary skill in the art by describing in detail exemplary embodiments with reference to the attached drawings in which:

FIG. 1 illustrates an embodiment of a vertical type memory device;

FIGS. 2A and 2B illustrate sectional views of the device in FIG. 1;

FIG. 3 illustrates string select lines (SSLs) and word lines in FIG. 1;

FIGS. 4A and 4B illustrate additional views of SSLs and word lines in FIG. 1;

FIGS. 5 to 17 illustrate a method of manufacturing the device in FIG. 1;

FIGS. 18 to 20 illustrate other methods of manufacturing the device in FIG. 1;

FIG. 21 illustrates another embodiment of a vertical type memory device;

FIG. 22 illustrates SSLs and word lines in the device in FIG. 21;

FIGS. 23 to 26 illustrate a method of manufacturing the device in FIG. 21; and

FIG. 27 illustrates an embodiment of an information processing system.

DETAILED DESCRIPTION

Example embodiments are described more fully hereinafter with reference to the accompanying drawings; however, they may be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey exemplary implementations to those skilled in the art.

In the drawing figures, the dimensions of layers and regions may be exaggerated for clarity of illustration. It will also be understood that when a layer or element is referred to as being “on” another layer or substrate, it can be directly on the other layer or substrate, or intervening layers may also be present. Further, it will be understood that when a layer is referred to as being “under” another layer, it can be directly under, and one or more intervening layers may also be present. In addition, it will also be understood that when a layer is referred to as being “between” two layers, it can be the only layer between the two layers, or one or more intervening layers may also be present. Like reference numerals refer to like elements throughout.

In the drawings, a vertical direction with respect to an upper surface of a substrate may be defined as a first direction, and two directions in parallel to the upper surface of the substrate while perpendicular to each other may be defined as a second direction and a third direction, respectively. Also, in one embodiment, the second direction may be an extended direction of a word line. In addition, the direction indicated by arrows and the counter direction thereof in the drawings may be regarded as the same direction. The definition on the directions may be the same through the drawings hereinafter.

First Embodiment

Referring to FIGS. 1 to 4B, an embodiment of a vertical type memory device which includes pillar structures 130 that extend in a first direction on a substrate 100. The substrate 100 may include a semiconductor material, for example, silicon and germanium. The device may also include a first tunnel insulating layer pattern, a first charge storing layer pattern, and a first blocking layer pattern stacked sequentially surrounding the pillar structures 130. The first tunnel insulating layer pattern, the first charge storing layer pattern, and the first blocking layer pattern are illustrated as one thin layer pattern 120.

A first word line structure 153a including stacked first word lines 152a surrounding the pillar structures 130, extending in the second direction and spaced apart from each other in the first direction, may be provided. A second word line structure 153b separated from the first word line structure 153a in the third direction and adjacently disposed to the first

word line structure 153a may be provided. The second word line structure 153b may include stacked second word lines 152b surrounding the pillar structures 130, extending in the second direction and spaced apart from each other in the first direction. A conductive connecting pattern 152c for connecting the first and second word lines 152a and 152b positioned at the same level may be provided.

The word lines 152a and 152b formed at the same level may make an electric connection by the connecting pattern 152c. The word lines and the connecting pattern formed at the same level may be called as a word line pattern 157 and may be explained as follows.

On the first and second word line structures 152a and 152b, a string select line (SSL) 154 surrounding the pillar structures 130 and extending in the second direction may be included. Wiring structures 160 and 162 may be included to independently input/output electric signals to the first and second word lines 152a and 152b at each layer. In one embodiment, the vertical type memory device may include a common source line (CSL) and a bit line.

Each pillar structure 130 may include a cylindrical shape channel pattern 122 extending from the substrate 100 in the first direction, and an insulating pattern 124 filling up the inner portion of the cylinder portion on the channel pattern. In addition, a pad pattern 126 may be provided on the channel pattern 122 and the insulating pattern 124. Thus, the pillar structure 130 may have a pillar shape. The channel pattern 122 included in one pillar structure 130 may be provided as a channel region of cell transistors and select transistors included in one cell string. The channel pattern 122 may include a semiconductor material.

A semiconductor pattern 116 contacting the substrate 100 and provided as the channel pattern of a ground select transistor may be further included at the bottom surface of the pillar structure 130. The semiconductor pattern 116 may have a pillar shape formed by using a semiconductor material.

In example embodiments, a plurality of the pillar structures 130 may be formed in parallel in the second direction and the third direction. Hereinafter, the pillar structures 130 may be classified into a first channel group and a second channel group and may be explained as follows.

The first channel group may include at least one pillar structure 130 in the third direction. The second channel group may be disposed adjacent to the first channel group and may include the same number of the pillar structures 130 as in the first channel group in the third direction. The number of the pillar structures 130 in the third direction, respectively included in the first and second channel groups, may be the same as the number of cell strings shared in the third direction with respect to one word line. Particularly, when one word line shares two pillar structures 130 in the third direction, as illustrated in the drawings, two pillar structures 130 may be included in the third direction in each of the first and second channel groups.

The first tunnel insulating layer pattern, the first charge storing layer pattern, and the first blocking layer pattern may be respectively provided on the outer wall of the pillar structure 130.

In example embodiments, the first tunnel insulating layer pattern may include an oxide such as silicon oxide. The first charge storing layer pattern may include a nitride such as silicon nitride. In addition, the first blocking layer pattern may include an oxide such as silicon oxide. The first blocking layer pattern may include a metal oxide having higher dielectric constant than the silicon oxide. Examples of the metal oxides that may be used may include aluminum oxide, hafnium oxide, lanthanum oxide, lanthanum aluminum

5

oxide, lanthanum hafnium oxide, hafnium aluminum oxide, titanium oxide, tantalum oxide, zirconium oxide, etc. These compounds may be used alone or as a stacked structure of two or more.

The first word lines **152a** included in the first word line structures **153a** may be supported by the pillar structures **130** and may have an extended shape in the second direction. The first word lines **152a** may extend in the third direction while surrounding a plurality of the pillar structures **130**. In an example embodiment, as illustrated in FIG. 1, the first word lines **152a** may extend while surrounding two pillar structures **130** in the third direction. That is, the first word lines may extend while surrounding the pillar structures **130** included in the first channel group. First insulating layer patterns **106** may be provided between the first word lines **152a** at the first to n-th layers in the first direction included in the first word line structure **153a**.

The second word lines **152b** included in the second word line structures **153a** may be supported by the outer wall of the pillar structures **130** and have an extended shape. The second word lines **152b** may extend in the second direction while surrounding a plurality of the pillar structures **130** in the third direction. In an example embodiment, as illustrated in the drawing, the second word lines **152b** may extend while surrounding two pillar structures in the third direction. That is, the second word lines **152b** may extend while surrounding the pillar structures **130** included in the second channel group. First insulating layer patterns **106** may be provided between the second word lines **152b** of the first to n-th layers included in the second word line structure in the first direction.

The connecting pattern **152c** may be provided between the first and second word line structures **153a** and **153b**, and may connect the side walls of the first and second word lines **152a** and **152b** at the same level. That is, the first word line **152a**, the second word line **152b** and the connecting pattern **152c** formed at the same level may be formed as one word line pattern **157**. When referring to the plan view in FIG. 4B, the word line pattern **157** formed at each layer may have an H-shape.

Between the connecting patterns **152c** in the first direction, a first insulating layer pattern **106** may be provided. In addition, between the first and second word line structures **153a** and **153b** in the third direction, a fifth insulating layer pattern may be provided.

The connecting patterns **152c**, and the first and second word lines **152a** and **152b** may include the same conductive material. The word line pattern **157** provided at the same level may be one body. As described above, the first and second word lines **152a** and **152b**, and the connecting patterns **152c** may be provided in the gap portions between the first insulating layer patterns.

The connecting patterns, the first word line, and the second word line **152a**, **152b** and **152c** may include a barrier metal layer and a metal layer. The barrier metal layer may be provided along the inner wall of the gap. In addition, the metal layer may be provided on the surface of the barrier metal layer and may have a shape filling up the inner portion of the gap.

As illustrated in FIG. 3, at each layer, the first word line **152a** may include at least one first barrier metal layer **151a** and a first metal layer **151b**, which contacts the first barrier metal layer **151a**. In one embodiment, the first barrier metal layer may be provided on upper and lower surfaces of the first word line **152a** and on the side wall of the pillar structure **130**.

Also, at each layer, the second word line **152b** may include at least one second barrier metal layer **151c** and a second metal layer **151d** contacting the second barrier metal layer **151c**. The second barrier metal layer **151c** may be provided

6

on upper and lower surfaces of the second word line **152b** and on the side wall of the pillar structure **130**. Also, at each layer, the connecting pattern **152c** may include a third barrier metal layer **152d** and a third metal layer **151e** contacting the third barrier metal layer **151d** on the upper and lower surfaces of the connecting pattern **152c**.

Examples of materials that may be used as the first to third barrier metal layers **151a**, **151c**, and **152d** may include titanium, titanium nitride, tantalum and tantalum nitride. These materials may be used alone or as a stacked structure of two or more. Examples of a material that may be used as the first to third metal layers **151b**, **151d**, and **151e** may include tungsten. Alternatively, the connecting patterns **152c** and the first and second word lines **152a** and **152b** may include polysilicon.

As illustrated in the drawings, the first and second word line structures **153a** and **153b** may be alternately disposed in the third direction. For example, in one embodiment, the first word line structures **153a** may be provided at even rows, and the second word line structures **153b** may be provided at odd rows.

A plurality of the first and second word line structures **153a** and **153b** may be provided in one cell block. The connecting pattern **152c** may have a shape connecting the first and second word lines **152a** and **152b** included in one cell block. Thus, as illustrated in FIG. 4B, the word lines positioned at the border portion of the cell block, which may be an edge of the cell block, may not make an electric connection to each other by the connecting pattern.

On the first and second word line structures **153a** and **153b**, string select lines **154** may be provided, respectively. The string select lines **154** may have a line shape extending in the second direction. At least one string select transistor may be required to be provided for one cell string and may not be shared in the third direction. Thus, the string select lines **154** may have an extended shape while surrounding one pillar structure **130** in the third direction.

One or more string select lines may be provided on one word line structure. For example, the first word lines **152a** included in the first word line structure **153a** may have an extended shape while surrounding two pillar structures in the third direction. Thus, two string select lines may be provided on the first word line structure **153a**.

The string select lines **154** neighboring in the third direction may be required to be electrically disconnected from each other. Thus, the connecting pattern **152c** may not be provided between the string select lines **154**. Meanwhile, on a portion of the side wall of the string select line **154**, a protruded portion A to a side portion may be included, as shown, for example, in FIGS. 3 and 4A. The protruded portion A may be formed, for example, by cutting the connecting pattern **152c** portion formed while manufacturing the string select lines **154**. Thus, the protruded portion A may be positioned at a portion for forming the connecting patterns **152c**. An isolated layer pattern **136** may be provided between the string select lines **154**.

A ground select transistor may be provided under the first and second word line structures **153a** and **153b**. Thus, a conductive pattern under the first and second word line structures **153a** and **153b** may be provided as a ground select line (GSL) **150**. The GSL **150** may have the same shape as the first and second word lines **152a** and **152b**. Also, the SSL **154** and the GSL **150** may be formed as one layer or more layers.

An independent electric signal may be applied into the first and second word lines **152a** and **152b** at each layer included in the first and second word line structures **153a** and **153b**. Thus, in one embodiment, the edge portion of the first and

second word lines **152a** and **152b** at each layer may be provided as a pad region for wire connection.

The first word line positioned at the lower layer in the first word line structure **153a** may have a long shape in the second direction. The length in the second direction of the first word line may become less approaching the upper layer. That is, the first word lines **152a** included in the first word line structure **153a** may have a step shape in an edge portion. The second word lines **152b** included in the second word line structure **153b** also may have the same shape as the first word lines **152a**. That is, the second word lines **152b** included in the second word line structure **153b** may have the step shape in an edge portion.

Also, insulating interlayers **112** and **132** covering the first and second word line structures **153a** and **153b** may be provided.

The wiring structure may independently input and output electrical signals into the first and second word lines **152a** and **152b** at each layer, and may include contact plugs **160** and wiring lines **162**. The contact plugs **160** may have a shape contacting at least one of the word lines **152a** and **152b** at each layer. The contact plugs **160** may contact the upper surface of the first or second word line **152a** or **152b** at each layer through the insulating interlayers **112** and **132**.

The first and second word lines **152a** and **152b**, at the same level in one cell block, may make an electrical connection by the connecting pattern **152c**. Thus, the contact plugs **160** may contact one word line among the first and second word lines **152a** and **152b** positioned at the same level. That is, only one contact plug **160** may be provided for the word lines **152a** and **152b** at one layer provided in one cell block. As illustrated in the drawings, when six layers of the word lines are provided for the first and second word line structures, six contact plugs may be provided in one cell block.

As described above, since the contact plugs may not be provided at both of the first and second word lines **152a** and **152b**, the number of the contact plugs may be substantially decreased.

The wiring line **162** may be respectively connected with the upper surface of the contact plugs **160**. Through the wiring line **162**, electric signals are required to be independently applied to the word lines **152a** and **152b** at each layer. Thus, in one embodiment, one wiring line **162** may be connected with respect to one contact plug **160**; that is, there may be a one-to-one correspondence between the wiring lines **162** and the contact plugs **160**.

As described above, in example embodiments, at each layer, the word lines **152a** and **152b** may be electrically connected by the connecting pattern **152**. Thus, additional wirings for connecting the word lines **152a** and **152b** at each layer may not be necessary. Thus, the connecting wirings may be simplified.

At the upper portion of the substrate **100** between the first and second word line structures **153a** and **153b**, an impurity region may extend in the third direction and function as a common source line (CSL). A number of layers may be formed on the impurity region, including but not limited to one or more of a metal silicide pattern such as a cobalt silicide pattern or a nickel silicide pattern.

A bit line may electrically connect to the pad pattern **126** through a bit line contact. The bit line may be formed, for example, from a metal, a metal nitride, doped polysilicon, etc. In example embodiments, the bit line may have an extended shape in the third direction.

As described above, in example embodiments, the word lines formed at the same level may be connected by the connecting pattern for connecting adjacent word lines. Thus,

the word lines in block units may electrically connect to each other by one or more of the connecting patterns. As a result, the contact plug and wiring line for connecting the word lines at each layer may be simplified.

FIGS. **5** to **17** illustrate perspective views, cross-sectional views, and plan views illustrated for explaining one embodiment of a method of manufacturing the vertical type memory device in FIG. **1**.

Referring to FIG. **5**, a first insulating layer **102** and a sacrificial layer **104** may be alternately and repeatedly stacked on a substrate **100**. Thus, a plurality of the first insulating layers **102** and a plurality of the sacrificial layers **104** may be alternately stacked in the first direction. The substrate **100** may include a semiconductor material such as silicon, germanium, etc.

In accordance with example embodiments, the first insulating layers **102** and the sacrificial layers **104** may be formed through a chemical vapor deposition (CVD) process, a plasma enhanced chemical vapor deposition (PECVD) process, an atomic layer deposition (ALD) process, etc. In accordance with example embodiments, the first insulating layers **102** may be formed by using silicon oxide, and the sacrificial layers **104** may be formed by using a material having an etching selectivity with respect to the first insulating layer **102**, for example, silicon nitride.

The stacking number of the first insulating layer **102** and the sacrificial layer **104** may vary according to the stacking number of the GSL, the word lines and the SSL formed in a following process. For the convenience of explanation, each of the GSL and the SSL, respectively may be formed as one layer. However, two or more of the GSL or the SSL may be formed, respectively. For illustrative purposes, six layers of the word lines are formed in the drawings. In one embodiment, $2n$ (n is a natural number of 1 or over) layers of the word lines may be formed. Thus, the stacking number of the first insulating layer **102** and the sacrificial layer **104** may not be limited to the number of the illustrated layers.

Referring to FIG. **6**, a portion of the first insulating layers **102** and the sacrificial layers **104** may be etched to form a step shape pattern structure **110** having a step shape edge portion. The step shape pattern structure **110** may have a stacked shape of first insulating layer patterns **106** and sacrificial layer patterns **108**. In the step shape pattern structure **110**, the first insulating layer pattern **106** and the sacrificial layer pattern **108** positioned at the lower portion may have long lengths in the second direction. The lengths in the second direction of the first insulating layer patterns **106** and the sacrificial layer patterns **108** may be decreased toward the upper layer in the second direction. In the step shape pattern structure **110**, one layer of the sacrificial layer pattern **106** and one layer of the first insulating layer pattern **106** may be stacked to form one layer having the step shape.

The step pattern structure **110** may be formed through performing a number of photolithography processes. The step forming portions at the edge portion of the step pattern structure **110** may be provided as connecting regions for forming connecting wirings.

A second insulating layer **112** covering the step pattern structure **110** may be formed. Then, the upper surface of the second insulating layer **112** may be planarized so as to expose the upper surface of the step pattern structure **110**. The planarization process may include a chemical mechanical polishing process.

FIG. **8** illustrates a cross-sectional view taken along a pillar structure portion in the third direction in FIG. **7**. Referring to FIGS. **7** and **8**, a plurality of channel holes **114** exposing the upper surface of the substrate **100** through penetrating the

second insulating layer **112**, the first insulating layer patterns **106** and the sacrificial layer patterns **108** may be formed.

The channel holes **114** may be formed by forming a hard mask on the uppermost first insulating layer pattern **106**, and performing a dry etching process using the hard mask as an etching mask. Thus, each of the channel holes **114** may be formed so as to be extended in the first direction. Due to the properties of the dry etching process, each of the holes **114** may be formed to have gradually narrowed width toward the lower portion. The channel holes **114** may be disposed in a row along the second and third directions in plurality.

A semiconductor pattern **116** partially filling up the lower portion of the channel hole **114** may be formed. Particularly, the semiconductor pattern **116** partially filling up the channel hole **114** may be formed by performing a selective epitaxial growth (SEG) process using the upper surface of the exposed substrate **100** by the channel hole **114** as a seed. Thus, the semiconductor pattern **116** may be formed so as to include single crystalline silicon or single crystalline germanium according to the material of the substrate **100**.

In some embodiments, impurities may be doped into the semiconductor pattern **116**. Also, in example embodiments, the semiconductor pattern **116** may be provided as a channel region of a ground select transistor (GST) in a following process. Thus, the upper surface of the semiconductor pattern **116** may be positioned between a layer including the GSL and a layer including the word line. However, the forming process of the semiconductor pattern **116** may be omitted to simplify the process.

Subsequently, a first blocking layer (not illustrated), a first charge storing layer, a first tunnel insulating layer, and a first channel layer may be formed one by one on the inner side wall of the channel holes **114**, on the upper surface of the semiconductor pattern **116** and on the upper surface of the hard mask. The first blocking layer may be formed by using an oxide such as silicon oxide, the first charge storing layer may be formed by using a nitride such as silicon nitride, and the first tunnel insulating layer may be formed by using an oxide such as silicon oxide. The first channel layer may be formed by using impurity doped or undoped polysilicon or amorphous silicon. When the first channel layer is formed by using the amorphous silicon, an LEG process or an SPE process may be additionally performed in a following process to transform the amorphous silicon into crystalline silicon.

The bottom portions of the first channel layer, the first tunnel insulating layer, the first charge storing layer and the first blocking layer may be partially removed to expose the upper portion of the semiconductor pattern **116**. Through performing the above processes, a first channel layer pattern, a first tunnel insulating layer pattern, a first charge storing layer pattern and a first blocking layer pattern may be formed on the side wall of the channel hole. In FIG. **8**, the first tunnel insulating layer pattern, the first charge storing layer pattern and the first blocking layer pattern are illustrated as one thin layer pattern **120**.

On the first channel layer pattern, a second channel layer may be formed. On the second channel layer, a third insulating layer filling up the inner portion of the channel hole may be formed and then, planarized. Through the planarization process, a channel pattern **122** of a stacked structure of the first and second channel layers may be formed. In addition, a third insulating layer pattern **124** filling up the inner portion of the channel hole may be formed.

The upper portions of the thin layer pattern **120**, the channel pattern **122** and the third insulating layer pattern **124** may

be partially removed to form a recessed portion. Then, a conductive material may be formed in the recess portion to form a pad pattern **126**.

Through performing the above-described processes, a pillar structure **130** including the channel pattern **122**, the third insulating layer pattern **124** and the pad pattern **126** may be formed in the channel hole **114**. In addition, the thin layer pattern **120** including the tunnel insulating layer pattern, the charge storing layer pattern and the first blocking layer pattern may be formed on the side wall of the pillar structure **130**.

The pillar structures **130** may be provided as channel regions of cell strings. Since one cell string may be provided with one pillar structure **130**, the arrangement of the pillar structures **130** may be the same as the arrangement of the cell strings.

In accordance with example embodiments, one word line extended in the second direction may share two or more cell strings in the third direction. Hereinafter, the pillar structure **130** may be explained after classifying into a first channel group and a second channel group according to the cell string shared by one word line in the third direction.

The first channel group may include at least one pillar structure **130** in the third direction and may be extended in the second direction. The second channel group may be disposed adjacent to the first channel group in the third direction, and may include the same number of the pillar structures as the number of the first channel groups in the third direction. Thus, the first channel group and the second channel group may be repeatedly disposed. Hereinafter, the first and second channel groups respectively including two pillar structures in the third direction will be explained.

FIG. **9** illustrates a perspective view illustrating an etched portion by a first etching process according to a following explanation. FIG. **10** illustrates a perspective view only illustrating a step pattern structure portion after performing the first etching process. FIG. **11A** illustrates a plan view of an exposing mask (reticle) used in the first etching process.

Referring to FIGS. **9** to **11A**, a fourth insulating layer **132** may be formed on the step pattern structure **110**. The fourth insulating layer **132**, the first insulating layer pattern **106** and the sacrificial layer pattern **108** may be partially and firstly etched to form first and second trenches **134a** and **134b** for forming an SSL.

As illustrated in FIG. **11A**, during performing the first etching process, an exposing mask including an exposing pattern **10** extended in the second direction may be used. The pattern formed portion of the exposing pattern **10** may become a portion to be etched. Thus, the first and second trenches **134a** and **134b** may have a line shape extended in the second direction. The first and second trenches **134a** and **134b** may be formed so as to penetrate the sacrificial layer pattern **108h** and the first insulating layer patterns **106h** and **106i** of a layer for forming the SSL.

Particularly, when the SSL is formed as the uppermost one layer, the uppermost sacrificial layer pattern **108h** and one of the first insulating layer patterns **106h** and **106i** positioned at the upper and lower portions of the sacrificial layer pattern **108h** may be partially removed to form the first and second trenches **134a** and **134b**, as illustrated in the drawings.

The first trench **134a** may be a trench provided in the first and second channel groups, and the second trench **134b** may be a trench provided between the first and second channel groups.

As described above, one word line may share a plurality of cell strings in the third direction. That is, a plurality of pillar structures **130** sharing the word line in the third direction may be included in the first and second channel groups. Since the

11

SSL may not share the pillar structures **130** in the third direction, one SSL line per one pillar structure **130** may be provided in the third direction. Thus, the first insulating layer patterns **106h** and **106i**, and the sacrificial layer pattern **108h** at the portion for forming the SSL may be additionally etched, so that the first insulating layer patterns **106h** and **106i** and the sacrificial layer pattern **108h** may have a line shape surrounding one of the pillar structures **130** in the third direction. As illustrated in the drawings, when two pillar structures **130** are included in the first and second channel groups along the third direction, the first trench **134a** may be formed between two pillar structures included in the first and second channel groups.

As illustrated in FIG. 1, the first word line included in the first channel group and the second word line included in the second channel group may be connected with a connecting pattern. However, the SSL may not share the pillar structures **130** in the third direction as the underlying first and second word lines. Thus, the SSLs positioned between the first and second channel groups may be separated. Accordingly, a portion disposed between the first and second channel groups of the first insulating layer patterns **106h** and **106i** and the sacrificial layer pattern **108** for forming the SSL may be required to be etched in advance. As illustrated in the drawings, the second trench **134b** may be formed at the portions of the first insulating layer patterns **106h** and **106i** and the sacrificial layer pattern **108h** between the first and second channel groups.

Referring to FIG. 12, after forming an insulating layer which sufficiently fills up the first and second trenches **134a** and **134b**, a planarization process may be performed to expose the upper surface of the step pattern structure. Through the above-described processes, an insulating layer pattern **136** may be formed in the first and second trenches **134a** and **134b**. The insulating layer pattern **136** may be formed by using a material having an etching selectivity with respect to the sacrificial layer patterns **108** including an oxide such as silicon oxide. In addition, the planarization process may include a chemical mechanical polishing (CMP) process and/or an etch back process.

In accordance with example embodiments, the forming process of the first and second trenches **134a** and **134b** and the forming process of the insulating layer pattern **136** may be conducted prior to the forming process of the channel hole **114**. That is, after forming the step pattern structure as explained referring to FIG. 7, the first and second trenches **134a** and **134b** and the insulating layer pattern **136** may be formed. Then, the forming process of the channel hole **114** to be explained referring to FIG. 8 in a following process may be performed.

FIG. 11B illustrates a plan view of an exposing mask (reticle) used in a second etching process to be explained hereinafter. FIG. 12 illustrates a perspective view of an etched portion after performing the second etching process. FIG. 13 illustrates a perspective view illustrating a step pattern structure portion after performing the second etching process. FIG. 14 illustrates a perspective view illustrating a sacrificial layer pattern after performing the second etching process.

Referring to FIGS. 11B to 14, a first opening portion **138** exposing the upper surface of the substrate **100** may be formed by partially etching the fourth insulating layer **132**, the step pattern structure **110** and the second insulating layer **112**. Through forming the first opening portion **138**, the step pattern structure **110** may become a mold structure for forming word lines and connecting patterns. In accordance with example embodiments, the first opening **138** may be formed by forming a hard mask on the uppermost first insulating layer

12

pattern **106**, and performing a dry etching process using the hard mask as an etching mask.

As illustrated in FIG. 11B, an exposing mask having an exposing pattern **12** having a hole shape extended in the second direction may be used in the second etching process. The pattern formed portion of the exposing pattern **12** may become a portion to be etched. In addition, the portion to be etched during the second etching process may overlap the portion for forming the second trench **134b**.

As described above, the first opening portion **138** may have a hole shape extended lengthwise in the second direction. Since a plurality of the holes may be provided in the second direction, the first insulating layer pattern **106** and the sacrificial layer pattern **108** may not be removed, but may remain between the holes in the second direction.

The first insulating layer patterns **106h** and **106i** and the sacrificial layer pattern **108h** for forming the SSL may have a respectively separated line pattern shape surrounding one pillar structure in the third direction. Besides, the first insulating layer patterns **106a** to **106g** and the sacrificial layer patterns **108a** to **108g** for forming the word line and the GSL may have a line pattern shape surrounding two pillar structures in the third direction, and the line pattern may have a connected shape at a portion.

As illustrated in FIG. 14, the first insulating layer patterns **106a** to **106g** and the sacrificial layer patterns **108a** to **108g** to be formed as the word line and the GSL may include a first stacking structure **140a**, a second stacking structure **140b** and a connecting structure **140c** for connecting the first stacking structure **140a** and the second stacking structure **140b**. The first stacking structure **140a** may have a line shape extended in the second direction while surrounding the pillar structures **130** of the first channel group. The second stacking structure **140b** may have a line shape extended in the second direction while surrounding the pillar structure **130** of the second channel group. The connecting structure **140c** may have a shape for connecting the side portions of the first and second stacking structures **140a** and **140b**.

From the plan view, the first stacking structure **140a**, the second stacking structure **140b** and the connecting structure **140c** may have an H-shape, similar to the plan view illustrated in FIG. 4B. On the outer side wall of the first insulating layer pattern **106** and the sacrificial layer pattern **108** positioned at the edge portion of the cell block region, the connecting structure **140c** may not be provided.

FIGS. 15, 16A and 16B illustrate cross-sectional views illustrating a method of replacing the sacrificial layer patterns with first and second word lines, SSL and GSL through a replacement process. FIG. 16A illustrates a cross-sectional view on a portion for forming a connecting pattern, and FIG. 16B illustrates a cross-sectional view on a portion excluding the connecting pattern.

Referring to FIG. 15, gaps **142** may be formed between the first insulating layer patterns **106a** at each layer by removing the sacrificial layer patterns **108a**. A portion of the outer wall of the first blocking layer pattern and a portion of the side wall of the semiconductor pattern **116** may be exposed by the gap **142**.

Referring to FIGS. 16A and 16B, a second blocking layer may be formed on the exposed surface of the gap **142**. Then, a barrier metal layer may be formed on the second blocking layer. A metal layer filling up the inner portion of the barrier metal layer may be formed. In accordance with example embodiments, the second blocking layer may be formed by using a metal oxide such as aluminum oxide, hafnium oxide, lanthanum oxide, lanthanum aluminum oxide, lanthanum hafnium oxide, hafnium aluminum oxide, titanium oxide,

13

tantalum oxide, zirconium oxide, etc. However, the second blocking layer may not be formed.

The barrier metal layer may be formed by using titanium, titanium nitride, tantalum, tantalum nitride, etc. These compounds may be used alone or as a stacked structure of two or more. The barrier metal layer may be formed along the surface profile of the gap **142**. The gap **142** may be incompletely filled up with the barrier metal layer.

The metal layer may be formed by using a metal having a low electric resistance such as tungsten. The metal layer may include, for example, tungsten.

The metal layer may be partially removed so as to remain the metal layer only in the gap **142**. That is, the metal layer formed in the first opening portion **138** may be removed. The removing process may include a wet etching process. Through performing the removing process, the sacrificial layer formed portion may be replaced with a conductive layer pattern including the barrier metal layer pattern and the metal pattern. The conductive layer pattern may be provided as an SSL **154**, first and second word lines **152a** and **152b**, a connecting pattern **152c** and a GSL **150** according to the positions. Through the removing process, the previously formed first opening portion **138** may be formed again.

That is, the conductive layer pattern formed at the uppermost sacrificial layer pattern **108** may become the SSL **154**. The conductive layer pattern formed at the sacrificial layer pattern **108** portion of the first stacking structure **140a** may become the first word line **152a** and the GSL **150**. The conductive layer pattern at the sacrificial layer pattern **108** portion of the second stacking structure **140b** may become the second word line **152b** and the GSL **150**. The conductive layer pattern at the sacrificial layer pattern **108** portion included in the connecting structure **140c** may become the connecting pattern **152c**.

Through performing the above-described processes, as illustrated in FIGS. **3** and **4B**, first and second word line structures **153a** and **153b** and the connecting pattern **152c** may be formed. On the first and second word line structures **153a** and **153b**, the SSL **154** may be formed. As illustrated in FIG. **3**, an extruded portion may be formed at the side portion of the SSL **154**. Since the SSL **154** may be formed by cutting the upper portion of the portion for forming the connecting pattern **152c**, both sides of the cut portion may have extruded shapes.

The word lines formed at the same level may have an electrically connected shape by the connecting pattern. Each of the word line patterns **157** formed at the same level may include word lines extended in the second direction and repeatedly disposed in parallel to each other in the third direction, and connecting patterns for connecting the side walls of the word lines so as to make an electric connection of the word lines repeatedly disposed in parallel to each other in the third direction. The word line pattern **157** may have a stacked shape of a plurality of layers separated from each other in the first direction.

Impurities may be doped into the upper portion of the substrate **100** exposed through the bottom surface of the first opening portion **138** to form an impurity region. Also, metal silicide pattern may be formed in the impurity region.

A fifth insulating layer pattern **156** filling up the first opening portion **138** may be formed. In order to form the fifth insulating layer pattern **156**, an insulating layer filling up the inner portion of the first opening portion **138** may be formed, and the insulating layer may be planarized until the upper surface of the uppermost fourth insulating layer may be exposed. In accordance with other example embodiments, the fifth insulating layer pattern having an inner spacer shape may

14

be formed on the side wall of the first opening portion **138**, and a common source conductive pattern filling up the first opening portion **138** may be formed on the fifth insulating layer pattern.

Referring to FIG. **17**, a sixth insulating layer may be formed on the fourth insulating layer and the fifth insulating layer pattern **156**. Through etching the sixth insulating layer, the fourth insulating layer and the second insulating layer, contact holes **158** exposing the word lines at each layer having a step shape may be formed.

As illustrated in FIG. **4B**, the first and second word lines **152a** and **152b** positioned at the same layer may have an electrically connected state by the connecting pattern **152c** by the cell block unit. Thus, the word lines positioned at the same layer in the cell block may be connected with one contact plug. Accordingly, each of the contact holes **158** may expose the upper surface of one of the word lines positioned at the same layer in the cell block. In addition, in the cell block, the same number of contact holes **158** as the number of the layers of the word lines formed in the cell block may be formed.

A conductive layer may be formed in the contact holes **158**, and the conductive layer may be planarized to form a contact plug **160**. The conductive layer may include a metal. The conductive layer may include a barrier metal layer and a metal layer. The barrier metal layer may include, for example, titanium, titanium nitride, tantalum, tantalum nitride, etc. These compounds may be used alone or as a stacked structure of two or more. The metal layer may include, for example, tungsten.

As described above, since all of the first and second word lines **152a** and **152b** may not be provided with the contact plug, the number of the contact plugs may be largely decreased.

Referring to FIG. **1** again, a wiring line may be formed on the contact plug **160**. The wiring line may become a pattern for respectively applying an electric signal to the contact plug **160**. Thus, one wiring line **162** may be connected to one contact plug **160**.

As described above, the first and second word lines included in the vertical type memory device may have a connected shape in the cell block unit based on the connecting pattern. Thus, additional wiring for connecting the first and second word lines in the cell block unit is not necessary. Thus, the wiring in the vertical type memory device may be simplified.

FIGS. **18** to **20** illustrate perspective views and a plan view corresponding to other embodiments of methods of manufacturing the vertical type memory device in FIG. **1**. The method of manufacturing the vertical type memory device as explained hereinafter may be the same as the explanation referring to FIGS. **5** to **17** except for the portion to be etched through the first etching process for forming an SSL.

First, the processes explained referring to FIGS. **5** to **8** may be performed to form the structure illustrated in FIG. **8**.

FIG. **18** illustrates a perspective view illustrating a portion to be etched using a first etching process to be explained hereinafter. FIG. **19** illustrates a perspective view illustrating a step pattern structure portion after performing the first etching process. FIG. **20** is a plan view of an exposing mask (reticle) used in the first etching process.

Referring to FIGS. **18** to **20**, a fourth insulating layer **132** may be formed on the step pattern structure. The fourth insulating layer **132**, the first insulating layer pattern **106** and the sacrificial layer pattern **108** may be partially and firstly etched to form a first trench **234a** and a first hole **234b** for forming an SSL.

As illustrated in FIG. **20**, in the first etching process, an exposing mask including a first exposing pattern **20a** having

15

a line shape extended in the second direction and a second exposing pattern **20b** having a hole shape between the lines may be used. The first and second exposing pattern portions may be portions to be etched by the etching process. Thus, the first trench **234a** may have a line shape extended in the second direction.

The first hole **234b** may be disposed between the first trenches **234a**. The first trench **234a** and the first hole **234b** may be formed at a layer for forming the SSL so as to penetrate the sacrificial layer pattern **108h** and the first insulating layer patterns **106h** and **106i**. Particularly, when the SSL is formed as the uppermost one layer as illustrated in the drawings, the uppermost sacrificial layer pattern **108h** and one of the first insulating layer patterns **106h** and **106i** positioned at the upper and lower portions of the sacrificial layer pattern **108h** may be partially removed to form the first trench **234a** and the first hole **234b**.

The first trench **234a** may be provided in each channel group, and the first hole **234b** may be provided between the channel groups.

Also, as illustrated in the drawings, when two pillar structures **130** are respectively included in the first and second channel groups in the third direction, the first trench **234a** may be formed between two pillar structures included in the first and second channel groups. The first hole **234b** may be positioned so as to face a portion for forming connecting patterns in a following process in the first direction.

Then, an insulating layer sufficiently filling up the first trench and the first hole **234a** and **234b** may be formed, and a planarizing process may be performed to expose the upper surface of the step pattern structure **110**. Through the above-described processes, an insulating layer pattern **136** may be formed in the first trench and the first hole **234a** and **234b**.

In accordance with example embodiments, the forming process of the first trench and the first hole **234a** and **234b**, and the forming process of the insulating layer pattern **136** may be performed prior to the forming process of the channel hole **114**. That is, after forming the step pattern structure **110** as described in FIG. 7, the first trench and the first hole **234a** and **234b**, and the insulating layer pattern **136** may be formed. After that, the forming process of the channel hole **114** as explained in FIG. 8 may be performed.

Then, a second etching process may be performed by the same method as explained referring to FIGS. 11B to 14. The exposing mask used in the second etching process may be the same as that illustrated in FIG. 11B.

Through performing the second etching process, the same structure as that explained referring to FIGS. 12 to 14 may be formed. Then, the same subsequent processes may be performed as those explained referring to FIGS. 15 to 17 to form the vertical type semiconductor device illustrated in FIG. 1.

Second Embodiment

FIG. 21 illustrates another embodiment of a vertical type memory device, and FIG. 22 illustrates SSLs and word lines in the device in FIG. 21. The vertical type memory device explained hereinafter may be the same as the vertical type memory device in the first embodiment, except that the word line may have a shape surrounding one pillar structure in the third direction. Also, in this example embodiment, the word line may have a shape which is not shared by multiple pillar structures in the third direction.

Referring to FIGS. 21 and 22, word lines **252** and connecting patterns **254** may be provided. The word lines **252** may be supported by the pillar structures **130** and may have an extended shape in the second direction. The word lines **252**

16

may be extended while surrounding one of the pillar structures **130** in the third direction.

The connecting pattern **254** may be provided between neighboring word lines **252** in the third direction and may connect with the side walls of the neighboring word lines **252** at a same level. The word lines **252** at the same level may be electrically connected by the connecting pattern **254**. The word lines and the connecting pattern at the same layer may be referred to as a word line pattern **157** and will be explained in greater detail below. At each layer, the word line pattern may have an H-shape from a plan point of view.

A first insulating layer pattern **106** may be provided between the connecting patterns **254** in the first direction. In addition, a fifth insulating layer pattern may be provided at a portion between the word lines in the third direction. The connecting pattern **254** and the word lines **252** may include the same conductive material. Also, the connecting pattern **254** and the word lines **252** provided at the same layer may be one body.

As in the first embodiment, each of the connecting patterns and word lines may include a barrier metal layer and a metal layer. Referring to FIG. 22, the word lines **252** at respective layers may include first barrier metal layers **251a** and a first metal layer **251b** which contacts the first barrier metal layer **251a** on the upper and lower surfaces of the word line **252** and on the side wall of the pillar structure **130**. Also, at each layer, the connecting pattern **254** may include a second barrier metal layer **251c**, and a second metal layer **251d** which contact the second barrier metal layer **251c** on the upper and lower surfaces of the connecting pattern **254**.

In addition, a plurality of word lines **252** may be provided in one cell block in the third direction. The connecting pattern **254** may connect the word lines **252** in one cell block in the third direction. Thus, the word lines **252** positioned at the boundary portion of the cell block, which may be an edge portion of the cell block, may be disconnected from each other by the connecting pattern **252**. That is, one of the word line patterns **257** may be positioned in one cell block.

String select lines **154** may be provided on the uppermost word lines **252**. The string select lines **154** may have a line shape extended in the second direction. As illustrated in the drawings, the word lines may be extended while surrounding one of the pillar structures **130** in the third direction, and may not share the pillar structures **130**. Thus, the string select lines **154** may have substantially the same shape as the word lines **252**. In addition, the string select lines **154** may face each of the word lines **252** in the first direction.

Since the string select lines **154** may be provided to be electrically separated in the third direction, the connecting pattern **254** may not be formed at the string select line **154**. Since the connecting pattern **254** may not be provided between the string select lines, the neighboring string select lines in the third direction may have a separate shape.

A ground select transistor may be provided under the lowest word line **252**. Thus, the conductive pattern under the lowest word line **252** may be provided as a ground select line (GSL) **250**.

In the vertical type memory device in accordance with example embodiments, word lines at respective layers may be connected by a connecting pattern in a cell block unit. Thus, an additional wiring for connecting the word lines may not be necessary. Thus, the wiring in the vertical type memory device may be simplified.

FIGS. 23 to 26 illustrate an embodiment of a method of manufacturing the vertical type memory device illustrated in FIG. 21. First, the processes explained referring to FIGS. 5 to 8 may be performed to form the structure illustrated in FIG. 8.

17

FIG. 23 illustrates a perspective view illustrating a portion to be etched using a first etching process to be explained hereinafter. FIG. 24 illustrates a perspective view illustrating a step pattern structure portion after performing the first etching process.

Referring to FIGS. 23 and 24, a fourth insulating layer may be formed on the step pattern structure. The fourth insulating layer 132, the first insulating layer patterns 106 and the sacrificial layer patterns 108 may be firstly etched to form first holes 300 exposing the substrate.

Through the first etching process, the inner portion of the first holes 300 may have a line shape extended in the second direction. The step pattern structure 110 between adjacent first holes 300 in the second direction may be unetched. The unetched portion 302 in the step pattern structure 110 may become a portion for forming a connecting pattern in a following process.

The first holes 300 may be formed in a portion between neighboring pillar structures 130 in the third direction. That is, the step pattern structure 110 between the first holes 300 may have an extended shape while surrounding the pillar structures 130.

At the exposed substrate in the first holes 300, an impurity region functioning as a common source line (CSL) may be formed. On the impurity region, a metal silicide pattern such as a cobalt silicide pattern, a nickel silicide pattern, etc. may be formed.

FIG. 25 illustrates a perspective view illustrating a portion to be etched by a second etching process to be explained hereinafter. FIG. 26 illustrates a perspective view illustrating a step pattern structure portion after performing the second etching process. Referring to FIGS. 25 and 26, an insulating layer sufficiently filling up the inner portion of the first hole 300 may be formed, and a planarizing process may be performed to expose the upper surface of the step pattern structure 110.

In the step pattern structure 110, a connecting pattern forming portion 302 in the uppermost layer for forming the SSL may be removed to form a second hole 304. Through forming the second hole 304, the uppermost sacrificial layer patterns 108 for forming the SSL may have a separated shape from each other.

Then, the same subsequent processes as explained referring to FIGS. 15 to 17 may be performed to form the vertical type semiconductor device illustrated in FIG. 21.

As described above, the word lines at each layer may be connected by the connecting pattern by the cell block unit in the vertical type memory device in accordance with example embodiments. Thus, an additional wiring for connecting the word lines may not be necessary. Accordingly, the wiring included in the vertical type memory device may become simplified, and the vertical type memory device may be easily manufactured.

FIG. 27 illustrates an embodiment of an information processing system 1100 provided with a vertical type nonvolatile memory device 1111. The information processing system 1100 may include a memory system 1110, and a modem 1120, a central processing unit 1130, a ram 1140 and a user interface 1150, respectively making an electric connection to a system bus 1160.

In the memory system 1110, processed data by the central processing unit 1130 or externally input data may be stored. Since the memory system 1110 may include the vertical type nonvolatile memory device 1111 in accordance with example embodiments, the information processing system 1100 may stably store a large capacity of data.

18

Even though not illustrated, the information processing system 1100 in accordance with example embodiments may be further provided with an application chipset, a camera image processor (CIS), a mobile DRAM, or an input/output apparatuses.

One or more of the embodiments described may correspond to a vertical type nonvolatile memory device. Particularly, the vertical type nonvolatile memory device may be manufactured by a simplified process in accordance with example embodiments.

Example embodiments have been disclosed herein, and although specific terms are employed, they are used and are to be interpreted in a generic and descriptive sense only and not for purpose of limitation. In some instances, as would be apparent to one of ordinary skill in the art as of the filing of the present application, features, characteristics, and/or elements described in connection with a particular embodiment may be used singly or in combination with features, characteristics, and/or elements described in connection with other embodiments unless otherwise specifically indicated. Accordingly, it will be understood by those of skill in the art that various changes in form and details may be made without departing from the spirit and scope of the present invention as set forth in the following claims.

What is claimed is:

1. A vertical type semiconductor device, comprising:

a plurality of pillar structures extending in a first direction, the pillar structures including channel patterns and being arranged in a second direction and a third direction crossing the second direction;

a first word line structure surrounding the pillar structures, the first word line structure extending in the second direction and including first word lines, the first word lines being spaced apart from each other and stacked in the first direction;

a second word line structure surrounding the pillar structures, the second word line structure extending in the second direction and including second word lines, the second word lines being spaced apart from each other and stacked in the first direction, the second word line structure being disposed adjacent to the first word line structure in the third direction;

a plurality of connecting patterns to connect side walls of adjacent first and second word lines, the connecting patterns being electrically coupled with the first and second word lines positioned at a same level; and

a plurality of string select lines coupled to string select transistors on the first and second word line structures, each of the string select lines surrounding at least one pillar structure in the third direction and extending in the second direction, the string select lines separated from the first and second word line structures.

2. The device as claimed in claim 1, wherein:

the first and second word lines and the connecting patterns are positioned at the same level correspond to word line patterns, and

the word line pattern in one layer is connected with one contact plug and one connecting wiring electrically coupled to the contact plug.

3. The device as claimed in claim 2, wherein the word line patterns are arranged in a block unit and wherein the first and second word lines positioned in a block region of the block unit are electrically connected.

4. The device as claimed in claim 1, wherein the connecting patterns at each layer are arranged in the third direction.

19

5. The device as claimed in claim 1, further comprising a ground select transistor including a ground select line, wherein the ground select line is under the first and second word lines at a lowest layer.

6. The device as claimed in claim 1, wherein the first and second word lines extend to surround at least one pillar structure in the third direction.

7. The device as claimed in claim 1, wherein the first and second word lines are wider than the string select line.

8. The device as claimed in claim 1, wherein the first and second word lines have substantially a same line width as the string select line.

9. The device as claimed in claim 1, wherein the connecting pattern includes a same conductive material as the first and second word lines.

10. The device as claimed in claim 9, wherein the conductive material comprises a barrier metal material including a metal nitride and a metal material including tungsten.

11. The device as claimed in claim 1, wherein:

a portion of the string select line facing the connecting pattern in the first direction is wider than another portion of the string select line.

12. The device as claimed in claim 1, further comprising a plurality of stacked layer structures, wherein each stacked layer structure includes a tunnel insulating layer pattern, a charge storing layer pattern, and a blocking layer pattern arranged on a side wall of a corresponding one of the pillar structures.

13. A vertical type semiconductor device, comprising:

a plurality of pillar structures extending in a first direction, the pillar structures including a channel pattern and being arranged in a second direction and a third direction crossing the second direction;

a word line pattern including word lines and connecting patterns, the word lines surrounding the pillar structures, extending in the second direction, and being repeatedly arranged in parallel in the third direction, the connecting patterns connecting side walls of the word lines to electrically connect the word lines repeatedly arranged in parallel to each other in the third direction; and

20

a plurality of string select lines coupled to respective string select transistors, each of the string select lines extending in a second direction and provided higher than an uppermost word line pattern and surrounding one pillar structure in the third direction, the string select lines separated from the word line pattern.

14. The device as claimed in claim 13, wherein a plurality of the word line patterns are stacked and spaced apart from each other in the first direction.

15. The device as claimed in claim 14, wherein one word line pattern of one layer is provided with one contact plug and a connecting wiring electrically coupled to the contact plug.

16. A vertical type semiconductor device, comprising:

a first word line;

a second word line;

a connector to electrically connect the first word line and the second word line to form a word line pattern;

at least one string select line over the word line pattern; and a number of pillars passing through the at least one string select line and the first and second word lines of the word line pattern, wherein the connector is substantially coplanar with the first and second word lines and is located at an area different from adjacent ends of the first and second word lines.

17. The device as claimed in claim 16, wherein at least two pillars pass through the first word line and at least two pillars pass through the second word line.

18. The device as claimed in claim 16, wherein the connector is to connect side walls of the first and second word lines.

19. The device as claimed in claim 16, further comprising: a plurality of the word line patterns in a stacked arrangement,

wherein ends of the stacked word line patterns are stepped in a predetermined direction.

20. The device as claimed in claim 16, wherein widths of each of the first word line and the second word line are different from a width of the string select line.

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